THE GEOGRAPHICAL REVIEW

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THE
GEOGRAPHICAL REVIEW

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THE REPOPULATION OF THE ROMAN CAMPAGNA

Roberto Almagià
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THE strange fascination of the Roman Campagna has been celebrated by writers of all countries and has inspired many an artist and poet. While other European capitals are surrounded by gardens and fields in the midst of which rise suburbs, villages, hamlets, and country houses, Rome stands in the midst of a wilderness. Whoever climbs to the top of the Torre del Campidoglio or to the dome of St. Peter's or, better still, to the summit of Monte Mario sees spread before him, beyond a very narrow belt of vineyards, orchards, and parks, a vast plain "beautiful in its amplitude of line and its air of desolation."[1] This region, the Roman Campagna or Agro Romano, is limited on the west by the Tyrrhenian Sea, on the north by the Sabatine Hills which enclose Lake Bracciano, on the east by the Sabine and Praenestine Mountains, and on the south by the Alban Hills. The Campagna, the area of which is a little over 2000 square kilometers, lies almost entirely within the Commune of Rome. It is traversed by the Tiber, whose lower course winds across a fairly broad flood plain. A little above Rome the Tiber is joined on the left by the Aniene. Considerably farther down the Arrone, or outlet of Lake Bracciano, joins it on the right, and there are many lesser tributaries usually called *fossi*. A little below the confluence with the Arrone the valley opens out and the delta region begins.

The Campagna for the most part is covered by eruptive materials from the Sabatine Hills to the north and the Alban Hills to the south, volcanoes that have been extinct since the Quaternary epoch. The

[1] One of the best accounts of the Campagna available in English is a translation of René Bazin's "The Italians of Today" (New York, 1908).

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lavas originating from the Alban Hills form long flows that reach to within a few kilometers of the gates of Rome and, on the north, to the Aniene. Much more widespread, however, are the tufas. Although in some places soft and easily eroded, the latter are frequently hard, compact, and lithoidal. Where this is the case the ground is covered with a resistant crust—the so-called *cappellaccio*—which is extremely difficult to break up. North of the Tiber above Rome blue clays (Pliocene) make their appearance in many localities under the volcanic deposits. The coastal zone, on the other hand, is covered with recent alluvium. Along the seashore there extend lines of dunes, or *tumoleti*, some now in the process of formation, others five kilometers back from the actual coast.

When viewed from one of the high points mentioned the Campagna seems like a monotonous, almost level, or slightly undulating plain. To anyone who crosses it on foot or horseback, however, it presents quite a different appearance, as it is traversed by a very large number of streams which have eroded a myriad of little ravines, *fossi*, in the unconsolidated tufas that constitute the greater part of the terrain.[2] Where a group of lesser *fossi* unites with a larger watercourse to form a finely meshed drainage pattern, the surface is dissected into detached hills—as for instance the famous Seven Hills of Rome.[3] As there are many *fossi*, springs, likewise, are not rare, and there are—or were in the past—numerous tracts covered with stagnant water or with pools, out of which grows a thick swampy vegetation; only near the sea, however, are marshes very extensive. There is a plentiful circulation of subterranean water, coming partly from the Alban and Sabatine Hills and partly from the more distant calcareous Apennines.

This territory, up to a few years ago, was practically a desert, dotted here and there with a few lonely hamlets and abandoned almost entirely to pasture, over which wandered many a herd of cattle and flock of sheep. The imposing ruins of aqueducts, villas, and tombs scattered over its surface gave to the Campagna a mysterious grandeur and desolation, which, combined with its absolute silence, exerted over the mind of every stranger an irresistible charm.

During the last few years, however, this state of affairs has been changing; a tremendous transformation is taking place with ever accelerating pace. The Campagna is being repopulated and restored to cultivation, the desert areas are constantly growing less extensive,

[2] Much has been written on the geology of the Roman Campagna. In "Monografia della città di Roma e della Campagna Romana" (2 vols., Rome, 1878) the geology was studied by P. Mantovani. A geological map on the scale of 1 : 100,000 accompanies this work. Later studies are those of G. Ponzi, R. Meli, G. Clerici, G. De Angelis d'Ossat, V. Sabatini, etc. See also the excellent essay on the Roman Campagna in Sir Archibald Geikie's "Landscape in History and Other Essays," London, 1905.

[3] W. M. Davis: The Seven Hills of Rome, *Journ. of Geogr.*, Vol. 9, 1910–1911, pp. 197–202 and 230–233.

and, if the process continues, in the course of a few decades, perhaps, the solemn desolation and profound silence will be only a distant memory. This transformation is of great interest to geographers not only because it is taking place in a region of unique historical importance but also because of the manner in which it is progressing.

FIG. 1.—Map of the Agro Romano and adjacent regions (1928). Numbers have reference: 1, boundary of city of Rome and suburbs; 2, boundary of commune of Rome; 3, railways; 4, tramways; 5, chief roads before reclamation; 6, chief roads built subsequently; 7, roads under construction; 8–11, population centers of varying degrees of importance (outside of the Agro Romano only the principal centers are indicated); 12, *borgate rurali* (see p. 548); 13, chief new agricultural centers; 14, principal *casali* (see p. 536); 15, hut villages. Scale of map approximately 1 : 850,000.

THE CAMPAGNA IN EARLY DAYS

The Roman Campagna was intensively cultivated at a very remote period, certainly long before the development of the Roman power. One of the most singular and at the same time most convincing proofs of this is to be found in that complicated system of tunnels, or *cuniculi*, which extend out in every direction beneath the surface on both sides of the Tiber as well as beneath the city of Rome itself and reach even as far as the northern flanks of the Alban Hills. These tunnels are

generally about a meter, although in some cases two meters, wide, frequently arranged in several series one above the other, and come together in wells now for the most part obstructed or entirely choked up. Whether, as many scholars think (including such archeologists as Ashby and Lanciani), they served for the draining off of the waters from the impermeable areas, where they are most numerous, or whether they served to collect and conserve drinking water for men and beasts and water for irrigation during the long dry summers, according to a recent and not improbable hypothesis,[4] the *cuniculi* prove that the Campagna was the scene of laborious and persevering activity at a very early date. In the early days of Rome there were many inhabited centers scattered over the region. Dionysius of Halicarnassus gives a list of 30 communities, or *populi*, forming part of the so-called Latin Federation, and there is an even older list in Pliny. With the help of these lists and from other sources we may reconstruct a series of some ten small cities, part of them south of the Tiber in Latium Vetus and others north of the river in what was then southern Etruria. One by one these towns fell before the growing power of the Romans and were destroyed, in some cases so utterly and at such an early epoch that it has not been possible to identify even their sites.[5] The conquered territory was divided by tribes, and the Latin Federation definitely broken up in 332 B. C. Some of the cities, however, remained as allies of Rome and, as such, enjoyed somewhat later periods of prosperity.

We know very little of the earliest network of roads in the Roman Campagna. At the end of the fourth century before Christ the construction of the great Roman roads began, a monumental undertaking which was carried on into the following centuries; but these great roads were built to facilitate communication between Rome and the more distant regions of the peninsula rather than to serve the immediate environs; they radiated from the city, with the lesser roads, stretching out like the spokes of a wheel. On the other hand, transverse highways were either entirely lacking or else were few in number. The characteristic divergence of the highways leading across the Campagna has been preserved down to the most recent times, even to within the last few decades, and has exerted a marked influence on the location and distribution of the center of population.[6]

In the most ancient times—before the sixth or fifth century before

[4] This hypothesis is explained in a penetrating discussion by Plinio Fraccaro: Di alcuni antichissimi lavori idraulici di Roma e della Campagna, *Boll. Reale Soc. Geogr. Italiana*, Ser. 5, Vol. 8, 1 19, pp. 186–215. Here the most important contributions on the subject are cited.

[5] Ameziola, Caenina, Cameria, Crustumerium, Collatia, Ficulea, Longula, Fortinea, Polusca, etc. Even in his time Pliny exclaimed, not without awe, "Ex antiquo Latio tres et quinquaginta populi interiere *sine vestigiis!*" (*Hist. Nat.*, III, 5 (9), 70).

[6] This characteristic of the network of roads is well shown on the map accompanying the recent work of Thomas Ashby: The Roman Campagna in Classical Times (London, 1927), on which are also indicated, so far as known, the routes of the secondary roads (*viae vicinales, diverticula*).

Christ—malaria, later to become a terrible scourge in the Campagna, had either not yet appeared, as Jones thinks, or else afflicted few people and, according to Celli, was of a mild type. Many writers regard this disease as the principal cause for the subsequent depopulation and the consequent decadence of the country. On malaria and its vicissitudes in the course of historical times a great deal has been written;[7] but, even though the propagating agent—the Anopheles mosquito—has been discovered, there are still many problems relating to malaria yet to be solved. According to Celli, this disease, like many others of an epidemic character, would seem to undergo alternate periods of virulence and attenuation, the result of biological factors inherent in the life and development of the propagating agent itself. During the period from about the fifth to the third century before Christ malaria appears to have presented a virulent phase, followed by a long period of attenuation from about the second century before Christ to about the third century of our era. Certainly not before the second century before our era did the habit of constructing villas and sojourning in the country in the neighborhood of Rome begin to become popular among wealthy Romans. This custom spread rapidly with the increase in prosperity and luxury during the last century of the republic and particularly under Augustus, who carried out great operations for regulating the Tiber both above and below Rome. The height of prosperity was, perhaps, reached here as in other parts of Italy under Trajan, Hadrian, and the Antonines. At that time no part of the Campagna was unoccupied by villas, parks, gardens, and cultivated tracts belonging to wealthy Romans. The drainage and irrigation of these estates must have been carefully controlled. However, there were not many centers of population in the Campagna itself even during this period of prosperity. Most of the well known earlier cities had been completely destroyed, and their ruins prompted writers and poets to point out, often in exaggerated terms, this sad decline as compared with the past glory of such places as Gabii, Fidenae, and Bovillae.

Decline of the Campagna

From the epoch of the Severi decadence set in, at first slowly but later spreading with ever increasing rapidity. Political struggles with the consequent abandonment of hydraulic systems, and later the barbarian invasions with a possible recrudescence of malaria, led to the abandonment of the Campagna for the greater part of the

[7] See W. H. S. Jones: Malaria: A Neglected Factor in the History of Greece and Rome, London, 1907. The most important work on this subject is a posthumous monograph by Angelo Celli: Storia della malaria nell' Agro Romano, *Atti Reale Accademia dei Lincei, Memorie Cl. di Sci. Fis.*, Ser. 6, Vol. 1, fasc. 3, 1925, with illustrations and maps; of great interest on account of the documents brought together on changes in the population of the Campagna from the earliest times to our own day.

entire medieval period.[8] It should be pointed out, however, that, contrary to the usual opinion, the Middle Ages did not represent the most desolate period in the history of the Roman Campagna. The investigations of Tomassetti[9] and others have shown that—at least from the point of view of depopulation owing to malaria—conditions were at the very worst in the seventeenth and eighteenth centuries.

FIG. 2—The *casale* of Pratolungo with its fountain.

Attempts to repopulate the region were not lacking. After the most turbulent period of the barbarian invasions had ended in the eighth and ninth centuries a series of enlightened popes undertook to establish rural centers, or *domuscultae*, particularly on the sites of ancient cities: to the right of the Tiber, Capracorum (now Isola Farnese near ancient Veii), Galeria near the ancient station of Ad Careias on the Via Claudia, and another Galeria farther south (Castle of Guido); between the Tiber and Aniene the *domuscultae* of Monte Gentile, Castellarcione, and Pratolungo; between Rome and the Alban Hills, Sulpiciana (between Capannelle and Marino) and la Falcognana; between Rome and the sea Calvisiana and Laurentina, etc. But in almost every case the settlement lasted only a short while.

Somewhat later there arose certain minor centers which would seem to have been somewhat more successful. These were known as

[8] The ingenious hypothesis of Ellsworth Huntington, according to which the fluctuations in the intensity of malaria and in conditions either more or less favorable to agriculture and population in the Campagna depend upon the alternation of periods of greater or less dryness, cannot, in the writer's opinion, be considered as proved, owing to the lack of the necessary corroborative data. Cf. Ellsworth Huntington: Climatic Change and Agricultural Exhaustion as Elements in the Fall of Rome, *Quart. Journ. of Economics*, Vol. 31, 1917, pp. 173–208.

[9] Giuseppe Tomassetti: La Campagna Romana antica, medioevale, e moderna, 3 vols., Rome, 1910–1913.

coloniae (possibly the relics of the ancient *villae*), *curtes* or *curiae*, and more particularly as *castra* or *casalia*. The last, often surrounded by walls and towers, served as the strongholds of the Roman barons, between whom severe and long-lasting feuds broke out which often culminated in pillaging, burning, and raiding. All this contributed to keeping the country in a desperate state. The power of the feudal

FIG. 3—The *casale* of Corcolle.

lords, which some of the popes and later the Commune of Rome itself sought in vain to restrain, reached its height in the thirteenth and fourteenth centuries. These nobles possessed immense *latifundia* which they dominated from castles erected on the ancient highways and connected by systems of intermediate fortified posts and watch-towers; the villages by necessity had to place themselves under the protection of one or the other of the barons, who in this way became their immediate masters. Many of the small centers nearer Rome were deserted by their inhabitants, who preferred to retire behind the walls of the city. Agriculture was more and more neglected, and herding became widespread over large tracts that had reverted to pasture.

In this way at about the end of the fifteenth or beginning of the sixteenth century there became established in the Roman Campagna a form of economic life whose vicissitudes may be followed down to our own day. A vivid picture of the situation at the end of the sixteenth century is provided by the great map of the Campagna by Eufrosino della Volpaia, dated 1547. Here the territory surrounding Rome over a radius of about twenty miles is drawn with such exactness that most of its cultural features can be identified. The Campagna

appears as an undulating tract broken by *fossi* and ravines; roads radiate from Rome; hamlets are shown, together with many conspicuous ruins and a multitude of watchtowers; cultivated lands are of very limited extent, almost wholly confined to the flanks of the hills of Tivoli and Montecelio, to the region between Zagarolo and the Aniene, and also to the south side of Lake Bracciano; almost everywhere else spread pasture lands; small ponds, pools, and marshes are frequent. Large tracts covered with *macchia* and brush abound in big game. Hares, wolves, and deer may be seen in the wood of Zagarolo.[10]

From the end of the sixteenth century we have an accurate register of all the estates in the Roman Campagna with the names of their possessors; a precise cadastral survey was carried out by Alexander VII about 1660.

The Great Estates

The Commune of Rome is divided into three parts: the city within the ring of walls; the suburbs, forming a narrow and irregular zone of very small holdings given over to gardens and vineyards; and the Agro Romano. The last is divided into estates (*tenute*) that vary greatly in extent, some being as large as a whole commune and others fairly small. Great proprietors have long been the owners of most of the estates, the total number of which, despite frequent transfers, was not greatly changed until a few years ago. At the time of Alexander VII (1655–1667) there were 425 estates; in 1770, 409; in 1890, 388; and in 1911, 413.

The center of each estate is the *casale*, with its fountain (Fig. 2). Each *casale*, or center of rural enterprise, is a massive, rectangular structure, surrounding an interior court. The latter, open to the sky and as large as a city square, is approached by a single gate. The building not only houses the personnel in charge of the estate but provides room for the storing of produce, and in the broad courtyard it is also possible, when necessary, to find place for the live stock. Attached to or built into one of the four corners of the structure there is usually a chapel.

In many instances the original plan of the *casale* has been modified. During periods of conflict between the great feudal lords or during times when brigandage flourished the edifice was fortified with towers and battlemented walls in such a way that it became a veritable miniature fortress equipped differently at different epochs according to changes in the art of military engineering.

The grandest and most beautiful of the *casali* were built on elevations that correspond, in some cases, to the citadels of ancient ruined

[10] This very rare map has been reproduced and is explained in great detail by Thomas Ashby: Mappa della Campagna Romana del 1547 di Eufrosino della Volpaia, Rome, 1914.

cities—as the Castel Giubileo on the *arx* of Fidenae, Castiglione on the *arx* of Gabii, Lunghezza (possibly on the *arx* of Collatia), Corcolle (Querquetula?), Castel di Leva (*arx* of Bovillae). Other *casali* represent *domuscultae* and *coloniae* of the Middle Ages. In the drier zones their position is often determined by the proximity of water; still other *casali* dominate points which roads must pass or where roads cross watercourses.

In some cases out of an enlarged *casale* a small village has developed, whose origin is manifest in the form and arrangement of the houses and in the single entrance gate through the surrounding walls. Such for instance are Practica, S. Vitorino, and Isola Farnese.

Until a few years ago these estates were in the hands of great proprietors, usually the owners of over 5000 hectares apiece. The proprietors themselves in the majority of cases did not exercise personal supervision but managed their estates through agents known as *mercanti di campagna*. The principal work on the estates was stock raising, the cultivation of grain being only of secondary importance. For the latter purpose the best soils on the level areas were used, where it was the custom to till the soil for two years in succession, alternating with two, or at least one, year during which it was allowed to lie fallow and was used as pasture (the system of *quarteria* or *terzeria*). The raising of horned cattle, including Swiss milch cows, attained a certain importance in the Campagna. Forage was procured by irrigating the meadows. Even now big half-ruined stables capable of holding 200 head of cattle and more are not an unusual sight. The raising of horses also was of considerable importance. The poorest pasturage was left to the sheep.

The common opinion that in the past the Roman Campagna was an almost entirely unused tract is erroneous. On the contrary, a traditional system of rural economy prevailed which had become adjusted to the complex of natural and social conditions and from which the great proprietors derived considerable profit with very little responsibility. The latter circumstance made it very difficult to effect any changes in the system, even though its maintenance was most unfortunate from the larger point of view of society as a whole.[11]

The Shepherds and Their Flocks

The evils of the agricultural system appear to have grown much worse between 1650 and 1800. This, as we have already seen, was

[11] There are many studies of the traditional economic system of the Campagna. One of the most widely known of these is Werner Sombart: La Campagna Romana, translated into Italian by F. C. Jacob, Turin, 1891. In the present writer's opinion the best treatment is that of Ghino Valenti: La Campagna Romana e il suo avvenire economico e sociale (estratto del *Giornale degli Economisti*, 1893), reprinted in his "Studi di politica agraria," Rome, 1914, pp. 145–252. Fundamental from the historical point of view is the book of C. de Cupis: Le vicende dell'agricoltura e della pastorizia nell'Agro Romano, Rome, 1913. By the same author is a bibliographical essay relating to the documents and laws concerning the Ager (Rome, 1903) with a supplement up to 1925 (Caserta, 1926).

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Hut near the old village of Marcelli and inhabitants of the village.

FIG. 5—Hut village of Vivaro.

FIG. 6—Flocks of sheep leaving the Campagna for the Abruzzi at the end of June.

probably the saddest period in the entire history of the Campagna, at least during modern times. A recrudescence of malaria led to the final abandonment of certain inhabited places, more particularly north of the Tiber between the Via Cassia and the Tyrrhenian Sea (for example, Galeria) and also south of the river in the zone nearest the sea. The pasturing of sheep flourished at the expense of other forms of rural economy, becoming its characteristic feature.

The shepherds, almost exclusively natives of the Abruzzi, pass the summer months with their flocks in the mountains of the Abruzzi. With the first cold weather during the second half of September they come down into the plains, retiring to the mountains after the middle of June. Thus the roads of the Campagna twice a year, towards the end of September and in June, offer an unusual spectacle. They are invaded by enormous flocks of sheep crowding together over stretches several hundred meters in length and stopping all traffic. With the aid of huge, fierce white dogs the shepherds drive them slowly forward taking ten, twelve, or fifteen days for the journey from the plains

to the mountains and vice versa. During the winter period the sheep in the Campagna do not occupy folds but remain out in the open air, inclosed at night in characteristic corrals made of a network of twine and known as *procòi*, "the same sheepfold as that which was used in the Caesars' time." The shepherds live in very primitive isolated straw huts. These are usually conical with a single low entrance and no other opening. There is a fireplace in the center, and around the sides are straw beds covered with skins—four, six, or sometimes eight beds to each hut. The furnishings in general are reduced to the indispensable minimum. Conveniently located near both herds and shepherds' huts are the milking places, circular enclosures. Such a characteristic establishment, known as *stazzo*, is completed by a little garden and sometimes by a row of small straw pens occupied by a few swine.[12]

The peasants who used to work by the day, particularly at harvest time, in the areas where grain is cultivated were also tempo-

[12] Much has been written on the manners and customs of the shepherds of the Roman Campagna. See Ercole Metalli: Usi e costumi della Campagna Romana, Rome, 1903; Giorgio Pullè: La pastorizia nella Campagna Romana, *Riv. Geogr. Italiana*, Vol. 22, 1915, pp. 490–501.

FIG. 7

FIG. 8

FIG. 9

FIG. 7—A typical view in the Maccarese region before reclamation.

FIG. 8—Pumping station of Maccarese.

FIG. 9—One of the new roads of the Campagna that link up the old system of radial highways.

FIG. 10—The hut village of Marcelli. Compare Figure 12.

rary inhabitants of the Campagna. They came from the more poverty-stricken regions of the Apennines and calcareous Subapennines of the vicinity of Rome and from the Abruzzi (Aquilani). They sojourned either in the *casale* or more often in straw huts quite as primitive as those of the shepherds but somewhat different in structure. Unlike the shepherds' huts, these were not isolated but were usually clustered in small groups, some of which were large enough to seem like villages. These people used to leave the Campagna a little later than the shepherds, in the middle of July. Thus during the summer period the height of desolation was reached.

The economic régime based on sheep pasturing was further strengthened because the shepherds of the Abruzzi who in the past had wintered in the plains of Umbria and the Marches now found themselves excluded from these regions, which had at length been given over to agriculture. They turned to the Campagna, offering ever higher rentals for the use of the pastures. The owners of the land were thus confirmed in their determination to maintain a system which enabled them to gain returns from their property not at all inferior to those received from agricultural land and a system which required almost no outlay of capital. The connection between the rural economy of the Campagna and that of the Abruzzian Apen-

FIG. 11—Peasant huts near the *casale* of Castiglione (Gabii) in 1908. Compare Figure 13.

FIG. 12—The *borgata rurale* of S. Cesareo which has taken the place of the hut village of Marcelli (Fig. 10).

nines became closer; and thus became crystallized the economic system which the Italian government found rooted in this region when in 1870 the Roman territory was joined to the new Kingdom of Italy. An improvement, however, took place during the nineteenth century through the intelligent but almost unknown work of the shepherds of the upper Abruzzo, especially of the Vissani, who introduced and spread over the Campagna a new breed of sheep based on the selection and crossing of different types of merino. This new breed is characterized not only by its great strength but by its very fine wool and, when it finds good pasturage, also by its excellent and abundant milk. Its introduction led to an increase in the making of a type of cheese (*pecorino romano*) in great demand in the markets of central Italy. A veritable industry thus arose which has lasted to the present day, although it is now monopolized by a few large producers who turn out the finished product from modern plants in which a high degree of technical efficiency has been attained.

THE BEGINNINGS OF RECLAMATION

When Rome became the capital of the new Kingdom of Italy in 1870 the crying need for the reclamation (*bonifica*) of the Campagna

FIG. 13—Modern buildings which have taken the place of the old huts near the *casale* of Castiglione (Fig. 11).

received prompt recognition. At the very gates of the capital lay a vast, unhealthy, and depopulated tract when the collective interest of the country demanded as a solution for the problem of its rapidly growing population new lands for the planting of crops, the gradual reduction of the *latifundia*, and the repopulation of the rural districts. Based on truly notable investigations, the laws of December 11, 1878, and of July 8, 1883, provided for a whole series of undertakings in the fields of hydraulic engineering and agricultural reclamation in the territory around the capital. The state was under obligation to carry out the drainage of the greater part of the marshy areas near the mouth of the Tiber, including the marshes of Maccarese to the north of the river, those of Ostia to the south, and of the Isola Sacra between the two branches of the Tiber. The drainage of other small ponds and low-lying swamps scattered over the Campagna was also provided for. Obligatory hydraulic syndicates were to undertake the connection of the springs, regulating the *fossi*, and, indeed, bringing under control the whole drainage system of the Campagna; individual proprietors were committed to the agricultural reclamation of all the lands surrounding Rome within a radius of ten kilometers from the *milliarium aureum* in the Forum.

Hydraulic reclamation in the coastal area was accomplished by the establishment of pumping stations and by the construction of a network of drainage canals to carry off the water to the sea. In this way there was drained, as a result of operations of great technical interest, an area of about 215 square kilometers (Maccarese, 108 sq. km.; Ostia, 94 sq. km.; Isola Sacra, 13 sq. km.). A part of the area lay beneath the normal level of the sea and presented conditions analogous to those prevailing in the *polders* of Holland. But this hydraulic reclamation, which may be said to have been brought to completion, was not immediately followed by agricultural settlement; since sanitary conditions remained unfavorable, the ground was left uncultivated or was used as pasture. At Ostia, to be sure, a colony of peasants from the Romagna was established. These people, after a victorious struggle against malaria during the first period of their settlement, built up a flourishing new agricultural center, which numbers at the present time (1927) about 1000 inhabitants. This was the initial step towards the repopulation of the coastal region of Latium, a movement very slow at the outset but one which has gradually gained in momentum, as we shall see below.

Among minor hydraulic undertakings are the draining of the swamps of Baccano and Stracciacappe near Lake Bracciano, the draining of the ancient Lake Regillus (Pantano di Castiglione), the regulating of the Fosso Almone, etc.

In the Roman Campagna proper, however, reclamation of agricultural lands and repopulation made little progress during the last

thirty years of the nineteenth century. This was due partly to the failure of the great landowners to carry out the duties imposed on them by law and partly to the persistence of malaria, against which no systematic campaign could be undertaken because of lack of adequate funds and for other reasons.

However, even before the Italian state intervened to promote the work of reclamation, a movement interesting from the geographical standpoint had already begun. Between 1860 and 1870 along the eastern and northeastern margin of the Alban Hills—which constitute a densely populated oasis devoted to the intensive cultivation of vines and olives—peasants from the poorest villages of the Apennines and from the calcareous Subapennines (such as Capranica Prenestina, Rocca di Cave, etc.) began to establish themselves. This folk came as temporary settlers during the period when agricultural labor was needed. They constructed hut villages often of considerable size (60 to 80 huts and more) but very primitive both in their construction and in their interior furnishings. Such habitations, suited for residence during the summer months, were at first occupied solely at this time of year. However, the period each year during which the inhabitants lingered in these settlements began little by little to grow longer, and finally the original mountain homes were abandoned altogether in favor of the new centers in the Campagna. The most important of these were Marcelli near S. Cesareo, Colle di Fuori and Carchitti farther south, Salto del Lupo near Pantano, Granaraccio near Aniene, Vivaro on the southern slope of the Alban Hills. For several decades these new colonists lived on in their primitive huts within a few kilometers of the capital of Italy quite unknown to the general public, without the benefit of medical or religious service, and without schools. Their settlements made a singular and disturbing impression on every visitor. But sooner or later the hut village, become permanent, tends to undergo a transformation, as we shall describe later. For the primitive hut with only a single entrance, dwellings of a more solid type two or three stories high have been substituted. Fires frequently destroy the older habitations, which are then replaced by new ones, often with walls. A few years hence the old, primitive type of habitation will perhaps have become only a memory of the past, but even today anyone who wishes to study the dwellings and their furnishings may find them in their most rudimentary state at Vivaro, the remotest and most completely isolated village of this unusual type in the neighborhood of Rome.

Reclamation Measures

The most recent phase of the movement toward the reclamation and repopulation of the Roman Campagna, a phase that has brought

really decisive results, may be said to have begun with the twentieth century. According to the laws of December 13, 1903, and November 10, 1905 (the latter coördinated all previous legislation, *Testo Unico*), the zone in which reclamation from the hydraulic and sanitary points of view was made obligatory on the part of the landowners was extended, particularly on the east beyond the radius of 10 kilometers from the Forum; in the watershed of the Aniene it was carried to the base of the Alban and Tiburtine Hills (in all, an area of about 440 sq. km.). A whole series of elaborate projects was authorized: provision of water for drinking and for use in irrigation, opening of connecting roads, and construction of dwellings for permanent and temporary laborers and of stables for live stock. The law of July 9, 1910, extended still farther the zone to be reclaimed, particularly on the north and on the west towards the sea. Subsequent provisions made in 1919, 1921, and 1926 included definitely in the zone of reclamation all the territory of the Commune of Rome and of the neighboring communes of Anzio and Nettuno, a part of the valley of the Tiber above Rome, etc. Provision was made in clear and forceful terms for the promotion of every useful enterprise in the field of reclamation and especially for projects for the erection of centers of agricultural colonization and rural habitation.

The progress of this work may be followed with the aid of the valuable official reports and statistical publications of the Commune of Rome[13] and on the topographic maps of the Campagna on the scale of 1 : 25,000, revised in 1924–1926 and recently completed by the Istituto Geografico Militare.

The warfare against malaria—systematized only after the discovery of the carrying agent or Anopheles—has been conducted energetically during the last few decades. It has been facilitated (at least, according to the views of Celli) by the circumstance that toward the middle of the nineteenth century a new period of natural attenuation of the disease seems to have set in. Scientific research has also played an important part in this campaign. Preventive measures (such as the wholesale distribution of quinine), a better food supply, and consequently increase in vigor and power of resistance on the part of the population, the use of metal screens on the doors and windows, the elimination of ponds, pools, and partially flooded areas, etc., have all contributed toward the successful outcome of this struggle which today seems a foregone conclusion. While only thirty years ago one

[13] Of especial importance are: Ministero di Agricoltura, Industria e Commercio: Il bonificamento dell'Agro Romano, Stato dei lavori al 30 giugno 1914, Rome, 1915; Ministero dell' Economia Nazionale: Il bonificamento dell'Agro Romano dal 1915 al 1925, Rome, 1925; *idem:* L'Agro Romano nel primo quinquennio fascista, Rome, 1928. The Commune of Rome has published the detailed results of the census of population of 1911, in which is presented among other things the population of all the estates of the Campagna on June 10, 1911. (Cf. Comune di Roma, Servizio di Statistica: Il censimento 10–11 giugno 1911 nel Comune di Roma, Rome, 1915, and Dizionario topografico di Roma, Rome, 1914.) Unfortunately, there is no analogous publication for the census of 1921.

might easily contract malaria at the very gates of Rome, today the disease is not a menace in any part of the Campagna except in certain coastal zones, from which, without doubt, it will be eradicated in its endemic form in the near future. The virtually complete eradication of malaria thus brought about was absolutely necessary before repopulation of the region could be seriously considered.

Cultivation of many tracts formerly untilled and used solely for pasture has been made possible by the breaking up of the *cappellaccio* by means either of explosives or of Fowler machines which plow up the soil to a considerable depth. In the first operations of this sort, which date from the years following 1918, the explosives used for the most part were those left over from the World War. After these initial experiments had proved successful the work was entrusted to a special company (the Society for the Mechanical Breaking-up of the Soil in the Agro Romano), whose business it has been to make ready large areas for the cultivation of grains or, indeed, here and there for the planting of gardens.

Another notable objective may now be said to have been reached: the providing of drinking water and water for irrigation. In some places new sources have been utilized; for example, on the flanks of the Alban Hills the Barbuta aqueduct distributes drinking water to new colonization centers. The Acqua Marcia, coming from the sources of the Alto Aniene—foremost among the waters which used to supply the city of Rome—is now being distributed more especially in the region between Tivoli and Rome. Many small and unimportant springs have been tapped and brought into connection with one another to irrigate areas formerly dry. On a larger scale recourse is being made to the water found everywhere beneath the surface. In places this provides an abundant supply, the depth and flow of which are well known as a result of many surveys. At an earlier period water was sought for through the restoration of ancient wells; but today borings are often made to very great depths (as much as 50 to 60 m.; at Torrenuova even to a depth of 82 m.), modern contrivances being used for lining these artesian wells with metal. In this way it has been possible to make use of sources of water more abundant and of more constant flow. The water is raised by windmills and by different types of electric pumps and is stored in reservoirs.

One of the enterprises that has exerted a most powerful influence upon the repopulation of the Roman Campagna has been the construction of a new network of roads, especially a system of transverse roads binding together the main ancient highways so that the Agro Romano is now broken up into a series of concentric belts at different distances from the city (see Fig. 1). Up to 1915 about 32 kilometers of these roads had been constructed; at the end of 1928 the state and the communal government of Rome had completed about 285 kilo-

meters. Besides these, there are also lesser roads built by the reclamation organizations (150 km.) and farm roads built by private individuals or syndicates. The construction of light railways has been of great benefit to the Campagna, notably the lines from Rome to the Alban Hills, to Fiuggi, to Civitacastellana, and to Ostia. The building of bridges over the Aniene and other watercourses also deserves mention.

The *latifundia* are being broken up little by little and subdivided either among small proprietors or into cultural units of modest area.

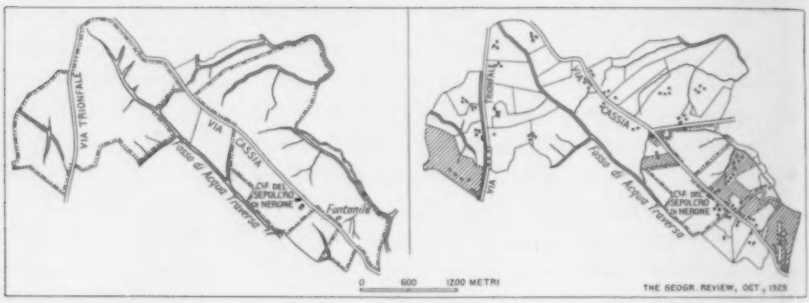

FIG. 14—On the left a great estate of the Roman Campagna in 1908: a single property of 6.73 square kilometers area whose economy was predominately pastoral. On the right the same estate subdivided in 1927. About the old *casale* is an agricultural center of 0.68 square kilometers; the remaining area is divided into 32 farms, each with a farmhouse; the obliquely shaded areas are divided into small lots with 70 cottages.

The total area of the estates—now a little less than 1850 square kilometers—has grown somewhat smaller during recent years because many nearest the city have been included in the tract reserved for urban buildings or else have been broken up into small suburban plots for market gardens. Furthermore, a narrow belt along the base of the Alban Hills has been absorbed into the great zone of vineyards and olive trees which is extending from the hills towards the plain. Of the remaining area (1820 sq. km.) about 250 square kilometers has already been broken up or is being broken up into small farms. Another 250 square kilometers is being divided among 330 small holdings (from 50 to 100 hectares); 291 square kilometers among medium-sized holdings (from 100 to 200 hectares); 134 square kilometers among large holdings (from 200 to 300 hectares); about 100 square kilometers among centers combining agriculture and stock raising; and more than 190 square kilometers among little pastoral centers which make use of the natural meadows that have been improved for the purpose. Many other estates are in the process of transformation. The traditional type of exclusively pastoral economy in the Campagna is now restricted to a few large estates, perhaps 25 or 26, comprising a total area of about 282 square kilometers (10 to 12 sq. km. to each estate on an average); these are found for the

most part in the least accessible zone northwest of Rome and along the coast.

Types of Settlement

We come now to the problem of how the repopulation of the Campagna is actually taking place. Isolated colonists' houses on farms of modest extent, such as are found in Tuscany, are still relatively rare. They occur for the most part not very far from Rome

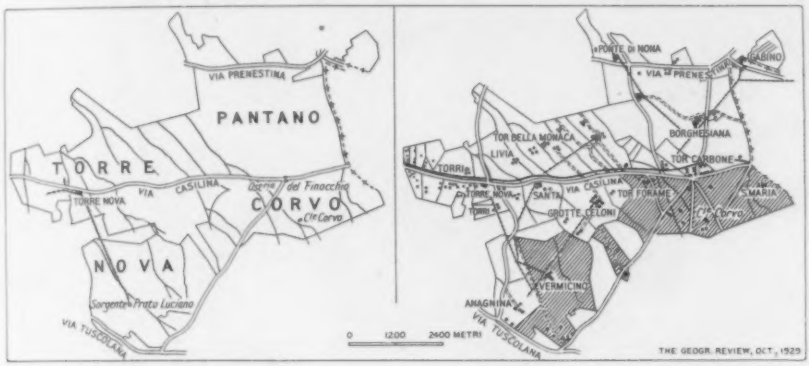

Fig. 15—On the left three large estates with two *casali* still belonging, in 1908, to a single proprietor. On the right the same property at the end of 1927, subdivided into 18 agricultural centers with 14 groups of buildings, 26 farms with 22 farmhouses, and many small lots (obliquely shaded area) with rural cottages.

in areas adapted to varied cultivation, well provided with water, and where small holdings are profitable. One of the most conspicuous examples lies north of Rome along the Via Cassia. Here a great estate known as the Sepolcro di Nerone up to about twenty years ago comprised one of the traditional pastoral centers with its single ancient *casale* (at 8 km. from Rome on the Via Cassia). Since then this estate has been split up: a large agricultural center (68 hectares) and a cluster of new buildings have appeared near the ancient *casale*, 110 small farms with 95 colonists' houses have come into existence.

Of more frequent occurrence, however, are more complex centers of colonization corresponding to a larger territorial unit and including several buildings used as dwellings, stables, and storehouses for agricultural products. On the immense estates of Pantano, Corvo, and Torrenova, belonging to Prince Borghese, a radical transformation has been wrought by the completion of extensive works of reclamation and by a comprehensive road-building program through the initiative of the members of this ancient family. On land formerly almost exclusively devoted to pasture and uninhabited (except for three ancient *casali*, centers of old pastoral units) there are today some fifteen active and prosperous agricultural centers, besides a vast zone broken up into small lots. There are now several hundred agricul-

tural centers of various types and characters, according to the prevalent form of cultivation. Some of them are quite complex, especially where stock raising is associated with agriculture. Many types of agricultural economy, well developed throughout the ages in the valley of the Po, have been experimented with. Centers that have grown up during the last few years have been given forgotten classical names: Collatina, Cornelia, Lucrezia. Schools for colonists have also been established, such as the one at Buffalotta, fully provided with a complete modern equipment. Here it is proposed to train agricultural experts and technicians in matters relating to rural industry and stock raising.

Larger centers, or villages in the Italian sense of the word, are already fairly numerous, whereas there were almost none up to a few years ago. As regards origin four different types of village may be distinguished.

The first type, of which we have already spoken, is the hut village, representing a transitional stage in the agricultural settlement of the Campagna. Having become permanent, the village tends to change; in some cases in place of the single huts large buildings have been substituted, each one accommodating up to twenty families (Pantano, Granaraccio); elsewhere the huts have been superseded by walled cottages, as at S. Cesareo. Here, today, dwell some 150 families to each of which a hectare and a half of land has been assigned. Thus a veritable center of colonization has sprung into existence, with a population of 800 inhabitants. Such a center is usually called a *borgata rurale*, a term applied to an agricultural village constructed *ex novo* in territory formerly quite uninhabited.

These *borgate rurali* constitute the second type of settlement, a type which had previously been tried out successfully in Apulia. The first *borgata rurale* in the Campagna was founded in 1911 at 7 kilometers from Rome near the station of Magliana on the route from Rome to Pisa; at the present time it houses about fifty families. As a typical example, the *borgata* of Acilia may be taken; this has developed since 1913 in territory previously devoted to pasture and wholly uninhabited. Here in the form of a quadrangle (about 400 by 900 m.) twelve buildings were first constructed, all exactly alike and each housing four families. To each family was assigned a half hectare of land to be devoted wholly to the culture of garden products. In the middle of one side of the quadrangle, which paralleled the railway from Rome to Ostia, a street six meters wide entered the enclosure. This street was crossed at right angles in the center of the quadrangle by another street. Very close to the place where the first of these streets opened out on the railway is the railway station; and close at hand is a square with the school, the post office, the sanitary station, the barracks of the *carabinieri*, and a few stores. According to the

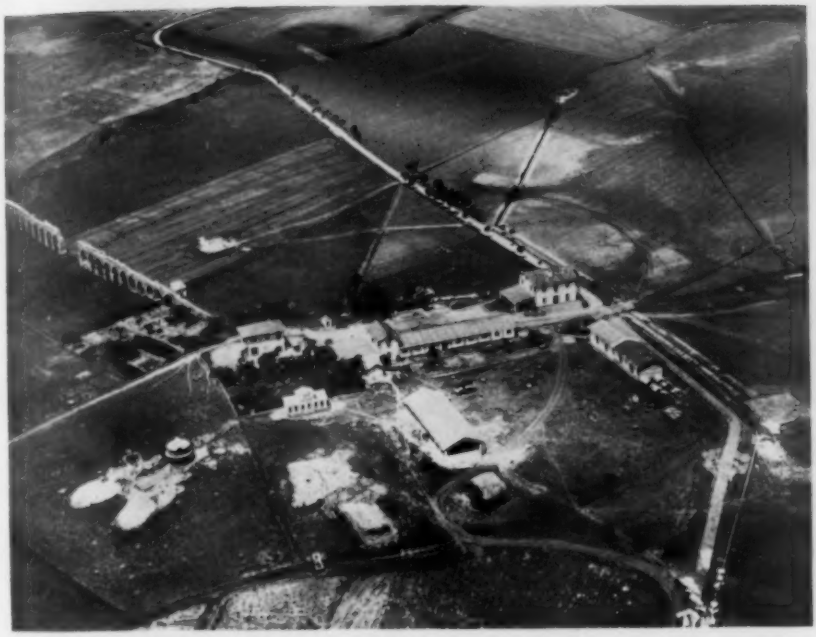

FIG. 16

FIG. 17

FIG. 16—The agricultural center of Casetta Mattei. To the left the ruins of a Roman aqueduct.
FIG. 17—The agricultural center of Salone.

FIG. 18

FIG. 19

FIG. 20

FIG. 18—Agricultural center of Pratolungo; cultivation of tobacco.
FIG. 19—Land reclaimed for cultivation in the valley of the *fosso* Acquatraversa.
FIG. 20—Soil broken up by Fowler machine.

FIG. 21

FIG. 22

FIG. 23

FIG. 21—The *borgata rurale* of La Magliana.
FIG. 22—School in the agricultural center of Maccarese.
FIG. 23—Building with quarters for the farmers and stables for cattle.

census of 1921 the *borgata* had 454 inhabitants. Since then it has been much enlarged by the construction of new rural buildings; according to a survey made in June, 1927, it had 735 inhabitants. Other *borgate rurali* are Barbuta on the Via Appia Nuova at 11 kilometers from Rome, founded in 1914 (25 families); Settecamini on the Via Tiburtina, 11 kilometers from Rome, founded in 1916 (35 families); Centocelle, on the Via Casilina, 5 kilometers from Rome, founded in 1921 (30 families); Ottavia on the Via Trionfale, 6 kilometers from Rome, founded in 1921 (48 families); Tor Sapienza on the Via Collatina, 6 kilometers from Rome, founded in 1922 (30 families); Maccarese, south of the old *casale*, in a zone where agrarian reclamation, begun as late as 1925, is now rapidly proceeding.

Villages of the third type are those that have grown up around the old *casali*. Some of the more favorably situated of the *casali*—distant descendants of the *domuscultae* of the Middle Ages and thus of the even more ancient cities of classical Latium—are being adapted as centers for the revival of rural life in the Campagna. Around the massive ancient building which has to house an increasing number of people from year to year, new dwellings and associated structures spring up, stores are opened, churches are revived, and public services—post office, school, and sanitary stations—are established. The new center takes form not as an artificial creation, as in the case of the *borgate rurali*, but as a result of spontaneous growth. Here also in some cases temporary huts have been used before the construction of permanent places of residence. Thus at Castiglione, where twenty years ago ten or twelve miserable huts clustered around the old *casale* on the site of the citadel of Gabii, modern buildings with stables and storehouses are being erected as dwellings for the colonists; Lunghezza (possibly the ancient Collatia) on the Aniene has now become a real village. In some cases the attraction of a railroad station has stimulated the settlement of a new village.

The fourth type is that of the maritime centers. As we have already pointed out, the coast in the neighborhood of Rome until a few years ago was absolutely depopulated on account of malaria. Between Civitavecchia and Anzio the only inhabited places were the old *casali* of S. Marinella, S. Severa, and Palo and the locality of Fiumicino, at the northern mouth of the Tiber; and most of the few inhabitants were temporary visitors or else small colonies of Neapolitan fishermen. With the draining of the marshes and the progress of reclamation new villages have developed, nearly all of which have now become flourishing bathing places. Anzio (first called Porto d'Anzio) did not have a thousand inhabitants in 1853, but today (1928) it is a lively little watering place with more than 5000 inhabitants. On the coast where La Marina di Ostia now stands there was not a single house fifteen years ago. Today this place is rapidly becoming a

veritable seashore suburb of Rome. Ladispoli, founded, as the name implies, by Ladislao Odescalchi on his great estates north of Palo, and very recently Fregene, on the shore near Maccarese, fashionable bathing resorts in the midst of a magnificent pine wood, have grown up out of nothing. The growth of these centers along the shore may be seen from the following table of inhabitants:

FIG. 24—Aerial view of Ostia Mare.

	1835	1901	1921	1927–1928
Anzio (center)	996	2481	4813	5500
Ostia (*borgata*)	...	427	570	955
Ostia Mare	...	...	233	779
Fiumicino	507	700	1178	1500
Ladispoli	...	30	428	550
S. Marinella	162	210	980	1300
S. Severa	130	90	437	500

The region of the Agro Romano least transformed up to date lies north and northwest of Rome between the Via Aurelia and the Via Cassia, and between the latter and the Tiber. Here, although a few new farming centers have appeared along the principal roads in the intervening districts settlement is proceeding quite slowly. The principal reason for this is probably to be found in the difficulty of access to this region, since it has been profoundly dissected by a fine network of torrents; furthermore, away from the old consular roads there still are no means of communication.

CHANGES IN LAND UTILIZATION

The most conspicuous result of the transformation in the system of landholding is the reduction of the natural pasture. Of a total of about 1820 square kilometers there remained as natural meadow in 1927 715 square kilometers, a figure which, it has been forecast, will be reduced to at least 500 square kilometers by 1930–1931. This reduction has been primarily in favor of the artificial meadows,

particularly of lucerne, the area of which, from 43 square kilometers in 1922, rose to 325 in 1927 and will reach about 460 in 1930–1931 (i. e. a more than tenfold growth in less than ten years).

The cultivation of cereals has likewise been greatly increased. The area devoted to cereals, less than 150 square kilometers in 1922, rose to 320 square kilometers in 1927 and will reach 380 in 1930–1931. There have been even greater gains in horticulture and, subordinately, in the cultivation of fruit, olive trees, and vineyards. The area particularly devoted to these types of agriculture was only 18 square kilometers in 1922 but had risen to 91 in 1927 and will reach 120 in 1931. Irrigated lands, about 8 square kilometers in 1922, will reach 60 in 1931.

It is very important to note that the decrease of the area in pasture has not been accompanied by a falling off in the live-stock industry. The raising of live stock, whether of sheep or horned cattle, has been much improved both as to type and breed, since the animals are now fed on the yield of the artificial meadows as well as on that of the natural pasture and are sheltered for the most part in stables and confined to restricted areas instead of being allowed to wander over wide spaces. The construction of stables of a modern and sensible type is one of the most striking facts that accompanied the recent repopulation of the Campagna. More and more sheep can now pass the summer months in the Campagna, avoiding the long and tiresome migration to the mountains; thus the old practice of transhumance, which dates back to the beginnings of history, is now tending to disappear. In 1907 there were in the Campagna stables enough to shelter possibly 2000 horned cattle but no sheepfolds. The number of horned cattle housed in stables had increased to more than 10,000 head in 1922, to 20,000 in 1927, and will exceed 30,000 in 1931. In 1922, 11,000 head of sheep occupied sheepfolds, 31,000 in 1927, and in 1931, according to forecast, more than 93,000 sheep will be accommodated.

Growth of Population

In conclusion some figures may be given relating to the increase in the total population of the Agro Romano within the limits of the communes of Rome, Anzio, and Nettuno.[14] Of the most recent decennial censuses only those of 1901 and 1921 are comparable, because they were both taken in the winter; whereas the intermediate census of 1911 was taken in the summer (June 30) when the greater part of the temporary population had left; the first census gave the total population on the first of February as approximately 25,200 (13 per sq. km.), the second as approximately 38,500 (20 per sq. km.). According to estimates as of the end of 1927 the population of the Agro must

[14] Excluding, however, the centers of Anzio and Nettuno.

have risen to 48,500; and it will exceed 55,000 in 1931, when the next census will be taken.

The population which is establishing itself permanently in the Campagna is being recruited for the most part from three different sources: (1) from among the inhabitants of Rome, in the new *borgate* and other centers of colonization nearest the city—as, for example, Ostia Mare and other seacoast localities; (2) from among the population of the Subapennine communes in the vicinity of Rome (Capranica Prenestina, Rocca di Cave; Camerata Nuova, etc.); (3) from among the inhabitants of the Abruzzi. The last are not only shepherds and herders but also include a few small artisans or casual laborers. Details in regard to this, however, are quite lacking and would be difficult to gather.

All we have attempted to do here is to give a summary statement of the principal aspects of the phenomena of agrarian reclamation and repopulation in the Roman Campagna. Other features, less conspicuous at the present time, will appear more clearly when these phenomena have developed on a larger scale and more fully. We have shown, however, that the repopulation of the region surrounding Rome may be considered now as definitely under way. A radical change is taking place in the appearance of the Campagna, a change which from the social point of view may without doubt be regarded as highly salutary.

GREAT SLAVE LAKE

J. Mackintosh Bell

IN the northern part of western central Canada the immense basin of Great Slave Lake forms one of the great physical features of the earth's surface. Until a few decades ago the region where this fresh-water sea is situated was regarded almost as an *Ultima Thule* in its remoteness, but in recent years ordinary means of communication have seen such a marked improvement that the casual traveler to this region can no longer consider himself a pioneer of exploration. Its shores, indeed, can be reached in a few hours' journey by airplane from the present railway terminus at Fort McMurray. What an amazing change from the days of the early voyageurs!

Though the suggestion is advanced, and not without probable foundation, that *coureurs de bois* from French Canada were the first white men[1] to visit the region of Great Slave Lake, the honor of its official discovery belongs surely to that redoubtable young English explorer, Samuel Hearne. Hearne, on his remarkable voyage of exploration from Fort Prince of Wales to the mouth of the Coppermine River, whither he had been lured by Indian stories of copper treasure, on the outward journey followed a route which left Great Slave Lake far to the westward, but on his way back, traveling southward from the headwaters of the Coppermine, he reached Great Slave Lake or, as he calls it, Athapuscow, a short distance east of the northern arm, on December 24, 1771.[2]

Whether or not that pioneer of the fur trade in Mackenzie River region, Peter Pond,[3] traveled along the southwestern shores of Great Slave Lake, as has been alleged, it is clear that two of his traders, Laurent Leroux and Cuthbert Grant,[4] built a fort there in 1785, at or near an easterly mouth of Slave River, between thirteen and fourteen years after Hearne's visit; and to this northern outpost came Alexander Mackenzie on June 9, 1789,[5] on his way to the great river which bears his name and which forms the outlet of Great Slave Lake.

[1] Émile Petitot: Autour du Grand Lac des Esclaves, 2nd edit., p. 78.

[2] Samuel Hearne: A Journey from Prince of Wales's Fort in Hudson's Bay to the Northern Ocean in the Years 1769, 1770, 1771, and 1772; new edit., by J. B. Tyrrell (Champlain Society Publs., Vol. 6), Toronto, 1911, pp. 253 et seq.

[3] H. A. Innis: Peter Pond and the Influence of Capt. James Cook on Exploration in the Interior of North America, *Trans. Royal Soc. of Canada*, Ser. 3, Vol. 22, 1928, pp. 131–141.

[4] L. J. Burpee: The Search for the Western Sea, Toronto, 1908, p. 416.

[5] Alexander Mackenzie: Voyages from Montreal, on the River St. Laurence through the Continent of North America to the Frozen and Pacific Oceans; in the Years 1789 and 1793: With a Preliminary Account of the Rise, Progress, and Present State of the Fur Trade of That Country, London, 1801, p. 7. (Reprinted as Vol. 3 of "Master-Works of Canadian Authors," Toronto, 1927.)

A small part of the southern shore of the lake is said to have been mapped by Philip Turner on the voyage which took him to the southern portion of the Mackenzie Valley between 1790 and 1792.

In the first half of the nineteenth century a number of distinguished geographers visited Great Slave Lake in the course of the explorations which were adding so greatly to the knowledge of the north-

FIG. 1—The mouth of the Yellowknife River looking west towards the main portion of the northern arm of Great Slave Lake. Glaciated rock surfaces in the foreground; vegetation flourishing under the protection of surrounding hills. (Photographed by J. M. Bell.)

western part of the continent at that period. On Franklin's first Canadian expedition[6] he crossed (1820) from the south shore to old Fort Providence on the northern arm of the lake, whence he departed on the expedition to the valley of the Coppermine River, fatal to so many of his followers; and on his second journey,[7] on his way to and from his headquarters on Great Bear Lake (1826–1827), he traversed the western arm. Back[8] followed the boat channel from the mouth of Slave River to the eastern end on his way to and from Fort Reliance (1833–1835), which he built to form the base of the explorations of the lakes to the northeast of Great Slave Lake and of Great Fish River now known by his name.

Though Mackenzie, Franklin, and Back each added accurate

[6] John Franklin: Narrative of a Journey to the Shores of the Polar Sea in the Years 1819, 20, 21, and 22: With an Appendix on Various Subjects Relating to Science and Natural History, London, 1823.

[7] John Franklin: Narrative of a Second Expedition to the Shores of the Polar Sea in the Years, 1825, 1826, and 1827: Including an Account of the Progress of a Detachment to the Eastward, by John Richardson, London, 1828.

[8] George Back: Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River, and along the Shores of the Arctic Ocean in the Years 1833, 1834, and 1835, London, 1836.

information to the knowledge of the nature of the region of Great Slave Lake, it remained for the venturesome missionary, the Abbé Petitot, to provide, as the result of his widespread wanderings in the sixties and seventies, the first comprehensive map of this part of Canada.[9] This extraordinary document, published in 1875, fundamentally inaccurate in detail but, when we bear in mind the multiplicity of islands and channels in the eastern part of the lake, giving a good impression of the general outline, remained for many years, with some modifications, the model accepted for the maps of northwestern Canada.

Since Petitot's time Great Slave Lake has been visited by many surveyors and geologists of the Canadian Government staff, in the forefront of whom were McConnell and Ogilvie, and by numerous other scientists and explorers, including Pike, Hanbury, Russell, Preble, and Douglas. A complete survey of Great Slave Lake was made between 1921 and 1925 by the Topographical Survey of Canada, and an accurate map of the great lake is now available. Much credit is due Blanchet[10] and the other topographers engaged for carrying through to a successful conclusion operations conducted during brief field seasons on a large body of water subject, more particularly during the late summer and early autumn, to tempestuous storms.

If one compares this modern map with that which accompanies Hearne's fascinating narrative, one observes that the latter conveys little idea of the lake's conformation. His name for the lake, Athapuscow, meaning in the Cree language "grass or reeds here and there," has strangely enough been transferred in the course of time to the next great lake to the south, Athabaska, where, as in the case of the Slave River at Great Slave Lake, there are reedy meadows at the mouth of the Athabaska River. He describes the lake as being "about one hundred leagues long from east to west and twenty wide from north to south." Considering the league as being 3.456 statute miles, these dimensions indicate a length of 415 miles and a width of 69 miles. The actual length from the foot of Big Island, which may be considered the head of the Mackenzie River, to Fort Reliance is about 300 miles, and the greatest width about 70 miles.

Petitot indicates that the aborigines call Great Slave Lake Tthou Tpoué or the Lake of Breasts (Lac des Mamelles), presumably on account of the peculiar topography of the hills at the eastern end.[11] He states that the lake extends from longitude 112° to 119° 30′ W. of Paris and transversely from latitude 61° to 63° N. These generalizations as to the geographical extent covered by the lake approach accuracy, but it should be remembered that Petitot had the advantage

[9] Émile Petitot: Géographie de l'Athabaskaw-Mackenzie et des grands lacs du bassin arctique, *Bull. Soc. de Géogr. de Paris*, Ser. 6, Vol. 10, 1875, pp. 5–42, 126–183, and 242–290.

[10] G. H. Blanchet: Great Slave Lake Area, Northwest Territories, [Canada] Topographical Survey, Department of the Interior, Ottawa, 1926.

[11] Petitot, Géographie de l'Athabaskaw-Mackenzie.

of the astronomical observations made by the British geographers who preceded him.

McConnell gave the superficial area of Great Slave as 10,400 square miles.[12] Cameron, with the results of his accurate surveys of the western arm at his disposal, not available at the time of McConnell's visit in 1887, increased this extent by 2400 square miles, or to a total of 13,100 square miles.[13] The latest topographical maps, including those of the eastern portion made subsequent to Cameron's investigation, suggest an area considerably less than his figures. Accurate maps have not yet been made of Great Bear Lake, which differs materially in character from Great Slave Lake, inasmuch as it would appear from available information to contain fewer islands and to be generally much deeper. The existing maps indicate an area of approximately 11,400 square miles. It is doubtful if Great Slave is as large as the suggested figure for Great Bear; but, if not the fourth, it is at any rate the fifth largest lake on the American continent, being certainly exceeded in size by Superior, Huron, and Michigan.

Climatic Comparisons

Great Slave Lake extends over more than two degrees of latitude, and naturally the climate of the northern part of the basin is in general more severe than that of the southern, but its variability is more influenced by longitude than by latitude. While complete meteorological statistics are not available from a sufficient number of points on the lake to enable us to speak authoritatively or exactly, it would seem from the date of disappearance of the ice that the climate along the eastern arm is more severe than that along the northern, and the northern in turn is harsher than that along the western arm. The last comes to some extent under the influence of the warm winds that blow through the low passes of the Rockies and temper the weather even in winter. The climate of the western part is, in fact, milder than one would expect from its northern situation, being much less severe than the climate in corresponding latitudes farther east on either side of Hudson Bay. The three summer months are characterized by dry and generally bright warm weather. Sometimes even there are spells of oppressively hot weather when the temperature soars above 90° F. The summer isotherms of Fort Resolution and Fort Providence correspond with those passing through southeastern Manitoba and the valley of the St. Lawrence near Quebec. Snow lies on the ground from October till April but never to a depth of more than two or three feet. Temperatures somewhat below −40° F.

[12] R. G. McConnell: Report on an Exploration in the Yukon and Mackenzie Basins, N. W. T., *Canada Geol. Survey Ann. Rept.*, Vol. 4 (N. S.), 1888–89, Part D.

[13] A. E. Cameron: Hay and Buffalo Rivers, Great Slave Lake, and Adjacent Country, *Canada Geol. Survey Summary Rept.*, 1921, Part B, p. 9.

have been recorded at Fort Resolution but are less extreme than at points on the prairies much farther south. Generally speaking, the winters are not more severe than in northern Ontario and, owing to the comparative infrequency of strong winds, are pleasanter. The western part of the lake ordinarily freezes in November, the eastern part a little earlier. The center of the western arm often remains free of ice till December, and McConnell reports that at a very deep point in the eastern part there is a channel open all winter. The ice leaves the western part of the lake in June, generally from the tenth to the twentieth. The eastern bays are not invariably clear for some weeks later. The delay in the departure of the ice in the eastern part of the lake, due in all probability mainly to a somewhat more severe climate, is, no doubt, accentuated by the absence of large rivers entering from the south, east of the mouth of the Taltson, and by the presence of numerous deep sheltered channels.

Forest and Swamp

The vegetation of the neighborhood of Great Slave Lake is essentially northern in character. The principal forest trees—white and black spruce, Banksian pine, tamarack, aspen, balsam poplar, and white birch—do not ordinarily attain the same size as in the valleys of the Slave River or the Hay River to the south or even on the islands of the southern part of the Mackenzie River to the west. In the rocky regions to the north and east, stands of even fair-sized trees are limited to sheltered valleys; the growth on the more exposed uplands is scant. The luxuriant vegetation in well protected ravines, even at the extreme eastern end of the lake, northern Canadian rather than Barren Land (Hudsonian) in character, suggests the existence of oases of milder climate; but the healthiness of the growth is due rather to shelter and good local drainage. The forest of the southwestern shores is more prolific, but it is open and parklike and not characterized by the thick, almost impenetrable undergrowth of the bush of northern Ontario or Quebec. The swamps in this southwestern section, probably on account of the relative dryness of the climate, lack the deep mossy surface characteristic of typical muskeg. The islands at the outlet of the Mackenzie and the neighboring mainland are reported "to exhibit a surface deposit of moss over ten feet thick." On the Department of the Interior map of Great Slave Lake (Western Sheet) the interior country near this part of the lake is said to be "low, swampy, and lightly timbered."

Game and Fur-Bearing Animals

The fauna of the region surrounding Great Slave Lake does not differ in any marked respect from that of northwestern Canada in

general. It is evident, however, from a perusal of the records of the old explorers, that the diminution of large game and of fur-bearing animals has been progressive and rapid. In recent years this may be attributed to the keen competition of rival fur-trading establishments, to the increase of forest fires, to the introduction of white trappers, and more particularly to indiscriminate destruction by the aborigines since the general introduction of high-powered rifles. The moose deer was formerly common all around the shores of Great Slave Lake; it is now rarely seen. In Hearne's time the wood buffalo appears to have existed even on the eastern side of the Slave River, where that explorer left the lake in traveling south, and it also roamed the open country north of the outlet of the Mackenzie. It is now limited to the area north and east of the Caribou Mountains situated between Great Slave Lake and Peace River, where the authorities are now making determined and apparently successful efforts to protect it from the onslaught of hunters. Until twenty-five years ago, Barren Land caribou visited the eastern bays of Great Slave Lake in considerable herds in the annual migrations. Reports from old Hudson's Bay Company employees state that at a still earlier date they crossed the ice of the northern arm from the eastern side to the western in such numbers as to blacken the ice with a great moving mass which took days to pass. Now the hunters no longer find them on the shores of Great Slave Lake at any season of the year. They have to go farther and farther on the Barren Lands to the east before the herds are encountered. While the route of the migrations varies from year to year—a circumstance which leads to reports that the animals are disappearing—they are apparently still numerous, but they will not long remain so if the Indians are permitted to continue their methods of destruction. Apparently when a herd is encountered the killing does not cease until all available ammunition is exhausted.

Most, if not all, of the species of fur-bearing animals have become lamentably scarce. This may be in part due to the fact that the hare, on which a number of the other species feed, is passing through one of its periods of decline in numbers, owing to the ravages of the peculiar intermittent disease from which it suffers. It is said that the extermination of the fur-bearing animals is practically complete over considerable areas and that in certain sections one may travel fifty or sixty miles across the winter snow without seeing so much as the track of a single animal!

The Settlements

Fort Resolution and Fort Rae are the largest villages on Great Slave Lake. Fort Providence is situated on the Mackenzie River, a short distance below the lake. There are less important settlements at Fort Reliance at the eastern end; at Snowdrift, at the mouth of the

river of the same name on the southeastern shore; at Yellowknife, situated near the point where the large river of similar name enters the northern arm; and at Hay River, on the southwestern shore. None of these communities has a permanent population of more than a few hundred. The inhabitants of the principal settlements consist mainly of European traders, missionaries, members of the Royal Canadian Police and a few other government officials, and the half-breed servants and associates of these individuals or organizations. At Fort Rae there are traders who are neither European, aboriginal, nor even Christian. They are Syrians—forming a remote outlier of Islam. Some of the half-breeds show by the fine old names they carry, and at times by an aristocratic bearing, that they are descendants of those romantic figures of the French régime, the *coureurs de bois*. The transient population at Fort Resolution and Hay River is swelled by the Indian children attending the missionary schools at these places, and at all the posts at certain seasons of the year by trappers, principally Indians, who resort there to trade and to enjoy for a brief spell the social amenities of the north. It is doubtful if the entire permanent population of the various posts amounts to five hundred.

The nomadic aboriginal population, trapping and fishing on the shores of the lake or in the region contiguous thereto, would not appear to number more than 1500 all told, and their number seems to be declining. Like all natives, they are subject to epidemics to which they succumb with a rapidity unknown in civilized communities. In the summer of 1928 an outbreak of influenza, in many cases followed by pneumonia, carried off 46 persons out of a total of 901 in the entire parish of Fort Resolution (which includes Yellowknife and other outlying communities), and, had it not been for the devotion of the Catholic priests and sisters, it is probable that the loss would have been much greater. The outbreak worked similar havoc at the other settlements. Another report is to the effect that twenty per cent of the native population died.

The aborigines belong to the Déné, or Athapascan, race, the variations of whose harsh guttural language may be heard throughout most of the valley of the great Mackenzie, among the Navajos and Apaches of Arizona and New Mexico, and among the Hupas of California. Around Great Slave Lake they are divided into three poorly defined tribes—the Slaves, living on either side of the western arm towards the outlet and extending down the Mackenzie; the Yellowknives, hunting around the river of the same name and near the eastern bays of the lake and trading at Fort Resolution; and the Dogribs, living between the northern arm and Great Bear Lake and trading at Fort Rae.

Petitot says that Great Slave Lake "doit ce nom à une tribu déné qu'y trouvèrent les premiers explorateurs, celle des Étcha Ottiné

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Great Slave Lake at Fort Resolution. (Photograph by G. M. Douglas.)
FIG. 3—Fort Resolution. Late summer. (Photograph by G. M. Douglas.)
FIG. 4—Indian encampment at Resolution waiting treaty payment. (Photographs 2 to 4 from the North West Territories and Yukon Branch, Canadian Department of the Interior.)

ou gens (vivants) à l'abri, sous-entendu des montagnes Rocheuses, Indiens dont les complaisances extrèmes et le servilité voisins de l'abjection leur valurent le nom d'Esclaves, tant des Anglais que des Français."[14] Mackenzie implies that the title of Slave was given to the Indians of this region as a term of reproach, rather than as a suggestion of servitude, by the Crees, who made frequent raids in days prior to the advent of the white man and who, being possessed of firearms, spread terror in the wake of their northern migrations.[15] Whether the origin of the name, Great Slave Lake, is reminiscent of the visits of these ancient warriors or is merely due to the character of the present inhabitants, the aborigines living in its vicinity have, in general, retained a servility, a feebleness, a meanness, an unreliability that entitles them all to the name borne by those dwelling near the western shores. Possessed of the truculence, the cruelty, the cunning of the Red Man, they lack the gaiety and consequent charm of the Eskimo, or the gallantry, constancy, and friendliness which the writer, at any rate, has observed among the Crees, Ojibways, and other Indian tribes of Algonquin stock. Commonly diseased, disliking the white man, whom, not unnaturally, they regard with suspicion as an intruder and the cause of the disappearance of the game, superstitious and pursuing a highly precarious existence, their life is drab, sordid, and singularly gloomy. But they are not devoid of good qualities; they are unusually patient under misfortune, possess remarkable endurance, and, though oversolicitous in their own behalf, are ready to treat hospitably those in distress, whether of their own race or not. Their legends indicate a sense of impish humor both childlike and engaging, while their conversation at times suggests poetic values which one would not ordinarily associate with so generally miserable a people. Warburton Pike relates a story of his faithful companion and guide, Saltatha, who, after listening to a disquisition by an old missionary on the merits of Heaven, replied, "My father, you have spoken well; you have told me that Heaven is very beautiful; tell me now one thing more. Is it more beautiful than the country of the musk-ox in summer, when sometimes the mist blows over the lakes, and sometimes the water is blue, and the loons cry very often? That is beautiful; and if Heaven is still more beautiful, my heart will be glad, and I shall be content to rest there till I am very old."[16]

Geology of the Region

With the exception of an inextensive outlier of Paleozoic rocks at the old site of Fort Rae, all of the eastern shore of the northern

[14] Petitot, Autour du Grand Lac des Esclaves, p. 74.
[15] Mackenzie, *op. cit.*, p. 3, footnote.
[16] Warburton Pike: The Barren Ground of Northern Canada, London, and New York, 1892, p. 276.

arm and the innumerable islands and shoals contiguous thereto are composed of Pre-Cambrian rocks. So also are the shores of the mainland and all the islands situated in the extensive part of the lake lying eastward of the northern arm on the north shore and of Stony Island on the south shore. Although the northern arm and the eastern bays of Great Slave Lake have been topographically surveyed, geologically

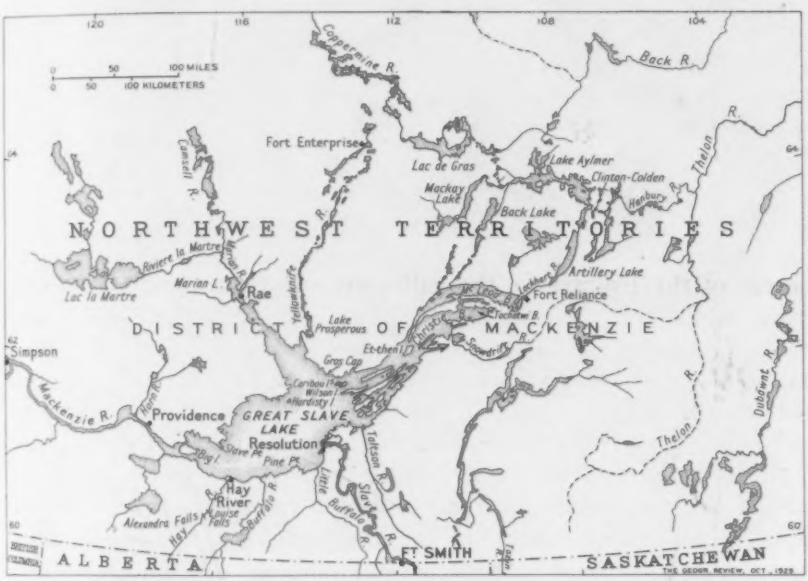

FIG. 5—Sketch map of Great Slave Lake. Scale approximately 1 : 9,000,000.

considered the region is almost *terra incognita*. In 1899 a geological reconnaissance of portions of the eastern part was made by Robert Bell,[17] and in the same year work of a similar character was done by the writer, acting as his assistant, elsewhere in the eastern bays and along the eastern shore of the northern arm. In 1921 Hume[18] visited one of the principal islands in the center of the lake, variously known as Caribou Island, White Island, and Wilson Island. In 1922 and again in 1928 a little geological work under the direction of the writer was done on Les Iles au Large and near the mouth of the Yellowknife River. In 1928 also George Douglas, [19] assisted by C. Lausen,[20] conducted a geological investigation along the southern shore from the mouth of the Taltson River eastward and made several trips inland.

[17] Robert Bell: *Canada Geol. Survey Ann. Rept.*, Vol. 12 (N. S.), 1899.

[18] G. S. Hume: *Canada Geol. Survey Summary Rept.*, 1929, Part B, p. 76.

[19] G. M. Douglas: A Summer Journey along the Southeast Shores of Great Slave Lake, *Canadian Mining and Metallurgical Bull.*, No. 202, February, 1929, pp. 344–360.

[20] Carl Lausen: A Geological Reconnaissance of the East End of Great Slave Lake, *ibid.*, pp. 361–392.

The whole of the western part of the basin of Great Slave Lake is underlain by Paleozoic rocks, which extend westerly from the western shore of the northern arm and from a short distance east of the mouth of the Slave River. The most easterly extension of the Paleozoic, that is the part contiguous to the Pre-Cambrian, consists of Ordovician-Silurian strata. Overlying these, westerly, come in succession the Middle Devonian and Upper Devonian. The superficial area over which the Ordovician-Silurian occurs is not great; these rocks occupy a narrow band striking approximately northwest along the western edge of the Pre-Cambrian.[21] The extension of the Middle Devonian is much greater. Outcrops of these rocks occur at intervals along the south shore of the western arm from near Fort Resolution to a short distance west of the mouth of the Buffalo and on the north shore from a short distance west of Hardisty Island to the foot of Deep Bay. Upper Devonian occurs at the extreme west of the lake and occupies a large area in the valley of the Mackenzie proper.

FIG. 6—The southern part of Kahochella Peninsula, eastern portion of Great Slave Lake, showing retreating escarpments of diabase (uppermost Pre-Cambrian) overlying limestone, which forms the gentle rock slopes. (Photograph by George Douglas.)

The Paleozoic rocks were deposited on the tilted edge of an ancient Pre-Silurian peneplain of Pre-Cambrian rocks and have a general westerly or southwesterly dip, forming a great monoclinal fold or possibly the easterly limb of a geosyncline. Suggestions of the westerly edge of this major structural trough appear on the eastern side of the Mackenzie in the vicinity of Fort Wrigley and elsewhere.

[21] Cameron, *op. cit.*, p. 13.

The eastern shore line of the Paleozoic epicontinental sea was probably roughly parallel to the present boundary of the Pre-Cambrian. To what extent long-continued erosion has caused the edge of the Paleozoic to migrate westerly, it is impossible to say. As far as the northern arm is concerned, judging by the outlier at the old site of Fort Rae, it is probable that Paleozoic rocks originally ex-

FIG. 7—A typical cove in Tochatwi Bay, eastern portion of Great Slave Lake. The photograph shows the flourishing vegetation where good shelter exists. (Photograph by George Douglas.)

tended at least as far as the eastern edge of this stretch of water.[22] The Paleozoics are in large measure shrouded by Quaternary material—glacial deposits and river and lake deposits. The thickness of the glacial deposits—stratified clays and boulder clays—appears to be very irregular. From such information as is available it would seem that the stratified clay is generally later than the boulder clay: the latter represents the ground moraine of the ice itself and the former deposits beneath the ice in its retreat or, more probably, in the greatly expanded lake near the retreating ice front.[23] The stratified clay may thus be regarded in part at least as transition material between the true glacial débris and the lacustrine beds of the later Quaternary. Moraines are fairly common but do not generally exercise much influence on the topography. McConnell indicates the existence of a prominent morainic ridge southwest of the western end of the lake, consisting of "a medley of steep-sided interlacing hills and ridges,

[22] D. B. Dowling: Geological Structure of the Mackenzie River Region, *Canada Geol. Survey Summary Rept.*, 1921, Part B, pp. 79–91; reference on p. 81.

[23] Charles Camsell and Wyatt Malcolm: The Mackenzie River Basin, *Canada Geol. Survey Memoir 108*, 1919, p. 82.

similar in appearance to those found on the Grand Côteau de Missouri of the plains."[24]

General Physical Features

For ease of description Great Slave Lake may be divided into four portions: the eastern portion, lying roughly easterly of a line connecting Gros Cap with the mouth of the Taltson River; the central portion, extending westerly to a line drawn from Hardisty Island to Fort Resolution; the westerly portion, continuing from this boundary to the mouth of the Mackenzie; and the northern portion, that part northward of a line drawn from Gros Cap to Hardisty Island.

Each of these divisions has distinctive physical features. The eastern portion, entirely within the area occupied by Pre-Cambrian rocks, has an extremely intricate shore line with a multiplicity of bays, sinuous channels, and innumerable islands varying in size from rocks a few feet in diameter to bodies of land many miles across. The western portion, within the Paleozoic strata, has a comparatively regular shore line with open bays and few islands. The central portion exemplifies the transition from the Pre-Cambrian to Paleozoic physiography with innumerable rocky islets to the east and a broad expanse of open water to the west. The northern portion, with Paleozoic rocks on the west and Pre-Cambrian on the east, partakes on the respective sides of a topography characteristic of the underlying rocks. It would be impossible to imagine a shore line more intricate than that to the east; the western margin is comparatively even and unindented. Lake Marian, which forms the northern extension of the northern arm, lying within Pre-Cambrian rocks, has a complex shore line.

Large as are the present dimensions of Great Slave Lake, the body of water which occupied the basin in the period immediately following the retreat of the continental ice sheet was even more imposing. A great arm stretched southward as far as the rapids on the Slave River at Fort Smith. Thence the southern shore line of the ancient lake trended northwestward, following probably the base of the escarpment which appears at intervals from the Salt River, a short distance west of Fort Smith, to the Hay River and probably farther. Many of the larger lakes to the south of the eastern portion of Great Slave Lake probably formed part of the original body. Though detailed information is not available, similarly it is believed that the whole of the original north shore line was very different from what it is today and that the ancient lake penetrated far to the northward. With isostatic readjustment after the departure of the ice sheet, the land rose and the lake boundaries gradually assumed their present general outline.

[24] McConnell, *op. cit.*, p. 25.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—The Blessed Isles (so called because of the absence of flies) in Tochatwi Bay, eastern portion of Great Slave Lake. The islands are of sandstone. (Photograph by George Douglas.)

FIG. 9—A rendezvous much used by the Indians, Pekanatui Narrows in the eastern portion of Great Slave Lake. (Photograph by George Douglas.)

FIG. 10—An old shore line on the north shore of Tochatwi Bay. (Photograph by George Douglas.)

The Eastern Portion

The highest land in the vicinity of Great Slave Lake is at or near the eastern end. Here "an abrupt rise of about 600 feet" leads "to a rolling plateau." Kahochella Peninsula is described as being formed of a massive escarpment rising to 800 feet and "approached from the water by a long talus slope."[25] Sentinel Point on Kahochella Peninsula is said to rise fully 1000 feet above the lake.[26] On the northwest side of Pethei Peninsula are sheer cliffs rising 200 feet to 500 feet from the water. Similar declivities are visible at many other points towards the east of the lake, more especially on the islands. Some of the diabase sheets occurring here have produced, in their erosional retreat, a cuesta-like effect. While the summits of the hills and ridges on both islands and mainland are essentially bare and rugged, those on the mainland both north and south appear to have generally more gentle outlines than on the islands.

The maximum heights gradually diminish in passing from east to west. The greatest height near Gros Cap probably does not exceed 200 feet; and the highest land at the eastern end of the Caribou Islands, Wilson Island, and the Simpson Islands is no more elevated. From the highly indented shore line in the vicinity of Gros Cap there is a steep rise of about 175 feet from the wooded water's edge to an almost absolutely flat plain of bare granite, devoid of any depression of more than a few feet but lightly covered in places by caribou lichen, which sloughs off as one walks over its surface, or by a thin growth of peaty material.

The flat surface at Gros Cap is believed to represent the level of the ancient Laurentian peneplain tilted from east to west; as do also the ridges, of even sky line, increasing in elevation in the direction of the eastern end of the lake. This ancient peneplain, Pre-Ordovician in age, has been subjected to long-continued dissection, since the advance of the Paleozoic sea, by normal fluviatile activities modified by glacial agencies.

The whole topography of the eastern division of the lake, with strings of islands, prominent ridges, and dividing channels, all trending northeasterly, shows strongly the influence of the geological structure. Certain very straight, long, narrow, well defined channels, such as the one between the western end of Keith Island and the Simpson Islands, suggest fault lines. The intricate outline of this section of the lake, the innumerable bays and channels, the multiplicity of islands, all show the submergence of a former main valley opening to the west with many tributaries.

While Great Slave Lake has not been systematically sounded, it

[25] Eastern Sheet, Map of Great Slave Lake (1 : 380, 160), 2nd edit., Department of the Interior, 1925.

[26] Lausen, *op. cit.*, p. 366.

is probable that the deepest water is in the eastern portion, more especially far to the east where the silt from the Slave River is not transported. The bottom in this part of the lake is probably composed mainly of glacial material, upon which in passing westward an increasing amount of modern silt is deposited.

Old shore lines all around the eastern part of the lake testify to its former extent. In the vicinity of Fort Reliance and Pike's Portage extensive sandy terraces, on which are well marked old beaches, stretch back to the surrounding hills. Fine examples of elevated beaches show along the north shore near Taltheilei Narrows.

All of the rivers flowing into the eastern part of the lake are characterized by numerous waterfalls; and some of those entering on the north shore, are unnavigable near their mouths owing to the series of rapids and falls by which they descend from the interior plateau. Lockhart River descends fully 400 feet in the twenty miles or so of its course from Artillery Lake to Charlton Bay (east part of McLeod Bay). Pike's Portage route—a chain of small lakes—is used by travelers to circumnavigate this stretch of broken water. The Hoarfrost River, which was followed by Back to its source in Walmsley Lake, has a very steep gradient. At its mouth there is a fall of 60 feet.

The two principal rivers of the south shore, the Snowdrift and the Taltson, though broken by rapids and falls, are of more gradual descent. George Douglas, in a personal communication to the writer, reports a waterfall of considerable height near the mouth of the Laloche River. The lower reaches of the Taltson come within the influence of the topography of the Slave River delta, as is testified by the low cliffs of silt near the mouth and the multiple stream channels flowing with even current.

The Central Portion

The central portion of Great Slave Lake is the remnant of what was formerly the main division stretching southward as far as the rapids of Fort Smith. Its present southern boundary from the Taltson River to Fort Resolution is formed by the delta of Slave River, which is constantly spreading northward. The Slave River at this point, nearly 1400 miles from its source at the head of Peace River, is a mighty stream bringing down vast quantities of silt in suspension and during high floods large amounts of driftwood. Much of the latter, especially the larger tree trunks, becomes stranded close to the numerous mouths of the Slave to form the nuclei of new bars and islands and thus accelerate alluviation. The courses of the river channels, ramifying through the shelf of shallow water extending far outward from the shore, are constantly changing. The shore itself, being composed of new land, is low and marshy; farther inland

willows appear; relatively older land is clad in cottonwoods; while where spruce forest is found at some miles from the present shore there is evidence of well established drainage.

In the eastern part of the central division of the lake are numerous groups of islands, Les Iles Basses, Les Iles au Large, Les Iles du Galet, and others. These represent the unsubmerged remnants of the ridges of the westerly pitching peneplain of Pre-Cambrian rocks. Around all of them are many shoals, rising but a few feet above the muddy lake bottom. The depth of the water in the central portion increases northerly towards the northern arm. It has not been sounded but is believed to be of no great depth at any point. It is nowhere free of silt but becomes clearer as the distance from the Slave River increases.

The islands are all small and low. The well glaciated elongated ridges on the larger ones are separated by narrow valleys filled with talus or glacial débris covered by peaty soil, supporting generally a scant vegetation but in places where local drainage is good a fair growth of trees. Stony Island, forming one end of long traverses to various points to the east and north of the lake, has consequently been visited by many travelers, who have reached its rather gloomy shores with a feeling of happiness after tempestuous journeys.

The Western Portion

The western division of Great Slave Lake, surrounded by generally low shores and filled with muddy water, entirely lacks the scenic charm of the eastern portion.

At Resolution a low range of hills appears above the silts of the Slave River delta and extends west into the lake, forming Mission Island. Similar ridges, reaching a maximum height of possibly 100 feet above the water, show along the south shore, at the mouth of the Little Buffalo River, near Pine Point, and at High Point. Higher ridges, reaching probably 250 feet in height but with slopes generally so gradual as to be scarcely perceptible, strike roughly parallel to the shore a few miles inland from Pine Point.

West of the mouth of the Hay River on the south shore and of Slave Point on the north shore the lake is bordered by low-lying swampy country. This low land is said to stretch for an unknown distance northward, while southward it is bounded by the Eagle Mountains, an escarpment rising 300 or 400 feet above the Mackenzie.[27] The dreary topography of the north shore from Slave Point northeastward towards Hardisty Island is but slightly relieved by numerous long, narrow ridges rising 100 to 150 feet above the lake

[27] E. J. Whittaker: Mackenzie River District Between Great Slave Lake and Simpson, *Canada Geol. Survey Summary Rept.*, 1921, Part B, pp. 45–55; reference on p. 47.

FIG. 11

FIG. 12

FIG. 13

FIG. 11—The limestone ramparts at Mellor Rapids, Buffalo River. (Photograph from Canadian Geological Survey.)

FIG. 12—Typical shore line of the delta of the Slave River, Great Slave Lake. The stranded tree trunks brought down by the river may be observed. (Photograph by George Douglas.)

FIG. 13—Driftwood on the southern shore of Great Slave Lake, east of the Slave River. (Photograph from Canadian Geological Survey.)

level and showing in many places, "low wave-cut cliffs facing lakewards, at elevations above the present lake-level."[28] Above and below the cliffs are numerous old lake beaches.

A few low-lying islands of limestone, strewn with Pre-Cambrian boulders and generally well wooded, divide Resolution Bay from the open waters of the lake. A number of low, swampy islands, the

FIG. 14—Alexandra Falls on the Hay River. The falls have a drop of 105 feet over limestone underlain by shale (Upper Devonian) and resemble Niagara in structure. (Photograph from Canadian Geological Survey.)

chief of which is Big Island, mask the entrance to the Mackenzie. Similar low islands are inconspicuous features along the north shore. The south shore is devoid of pronounced embayments; the north shore is indented by many deep, narrow, shallow bays, ending in marshes or in sloughs.

The water of the western arm is generally shallow: in many places it is difficult to approach the shore of the mainland even with small boats. The open bays of the south shore are ordinarily bordered by gravelly beaches strewn with immense quantities of driftwood and overlying low, shelving outcrops of solid rock. Large glacial boulders are scattered along these beaches and over the adjacent lake bottom, forming in the murky water a menace to navigation. Behind the gravelly beaches, narrow lagoons or swampy stretches are of common occurrence, paralleling the shore line. Inland from Pine Point are well developed old gravel beaches which, extending in long curves, tend to follow the gentle sinuosities of the existing shore line.

In regard to the portion of the lake west of the mouth of the Hay River and Slave Point, Cameron says, "This part of the lake is very shallow and the shoreline in most places is formed of boulder pave-

[28] Cameron, *op. cit.*, p. 11.

ments embedded in a soft blue-to-grey clay. Short, narrow points, formed of boulders derived from the Precambrian rocks east of the lake are very numerous, particularly in the deep bay north of the outlet, and boulder reefs occur at long distances from the shore. All the points have a tendency to parallel the direction of glacial movement"[29] (N. 85° W. astronomical). The outlet of the Mackenzie is at times so shallow as to affect the passage of the river steamers.

FIG. 15—The gorge between the Alexandra and Louise Falls, Hay River. The structure is similar to the Niagara gorge below Niagara Falls. (Photograph from Canadian Geological Survey.)

An extraordinary feature of the north shore of the western portion of Great Slave Lake is the absence of any entering streams of appreciable size. Little Buffalo River, Buffalo River, and Hay River flow into the lake from the south. The Little Buffalo rises in the eastern slopes of the Caribou Mountains and thence flows northeasterly to a point about 20 miles west of Fort Smith where it drops over the northern edge of the Alberta escarpment.[30] Thence its unbroken course closely parallels that of Slave River, from a few miles to a maximum distance of 25 miles to the east.

Buffalo River rises in Buffalo Lake, into which a number of small streams flow from the slopes of the Caribou Mountains. From Buffalo Lake to Great Slave Lake—a distance of 75 miles—rapids occur at a number of points, the principal being at about 20 miles above the mouth, where the river passes through a limestone gorge.

Hay River is a more important stream than either the Little Buffalo or the Buffalo. It is said to be 300 miles in length and to rise near the headwaters of Fort Nelson River. From 20 to 22 miles in a straight line from Great Slave Lake, Hay River precipitates itself over the edge of a pronounced escarpment, forming two falls

[29] *Ibid.*, p. 10.
[30] Camsell and Malcolm, *op. cit.*, p. 28.

about a mile and a half apart. At the upper of these, Alexandra Falls, there is a vertical drop of 100 feet. The lower, known as Louise Falls, have a total drop of 45 feet in a series of steplike chutes. Below the lower falls, the water flows through a gorge about five miles in length, the upper three miles being rapid water. While both falls are beautiful, Alexandra Falls are especially so. They form a veritable scenic gem in the midst of a vigorous spruce forest. A miniature Niagara in form, they bear another resemblance to the great cataract. The rate and extent of recession from the face of the escarpment to which they owe their origin, by a coincidence, has been about the same since glacial times.[31]

The Northern Portion

Excavated along the line of contact between the Pre-Cambrian and the Paleozoic rocks, the northern arm of Great Slave Lake shares the topographical peculiarities of both rocks. The topography of the east shore of the northern arm, apart from the vicinity of Yellowknife River, and that of Lake Marian lack the northeasterly trend characteristic of the eastern portion of Great Slave Lake, owing to the fact that most of the rocks are massive rather than bedded or sheared. Generally speaking, the country may be described as rough, broken, and irregular. The highest points are isolated rounded knobs, rather than well defined ridges. The most conspicuous hill in the country around Lake Marian is on its west shore; it reaches a height of perhaps 300 feet.

From the outlet of Lake Marian, which discharges into the northern arm by a number of short ramifying channels, to Gros Cap, the country is devoid of pronounced relief; close to the east shore there are few hills which exceed 125 feet in height. One of the most conspicuous elevations, strangely enough, is the isolated bluff of Paleozoic rocks at the old site of Fort Rae. This is a flat-topped butte about 100 feet high, situated near the end of a long point and separated from the low mammillated Pre-Cambrian hummocks to the east by a swampy isthmus elevated but a few feet above the water.

Yellowknife Bay, which forms the mouth of the river of the same name, penetrates eastward about ten miles from the main part of the northern arm, and the valley of the lower part of the river itself is eroded along a narrow trough of bedded and foliated rocks, producing a topography differing to some extent from that prevailing elsewhere along the eastern side of the northern arm. Ridges, generally short and hummocky but elsewhere elongated and possessing an even sky line, rise to 200 or 250 feet above Great Slave Lake. A

[31] A. E. Cameron: Post-Glacial Lakes in the Mackenzie River Basin, North West Territories, Canada, *Journ. of Geol.*, Vol. 30, 1922, pp. 337–353; reference on p. 353.

FIG. 16

FIG. 17

FIG. 18

FIG. 16—The flat, almost treeless plateau on the top of the Horn Mountains—a low elevation of limestone, northwest of the western portion of Great Slave Lake. The surface is typical muskeg. (Photograph from Canadian Geological Survey.)

FIG. 17—Sulphur and calcareous deposits at Sulphur Bay on the northwestern shore of the western portion of Great Slave Lake. (Photograph from Canadian Geological Survey.)

FIG. 18—Raised beaches at Le Gros Pointe, north arm of Great Slave Lake. (Photograph from Canadian Geological Survey.)

view from the top of any of these greater elevations discloses typical Laurentian scenery not unlike that of northern Manitoba or the rockier parts of northern Ontario—ridge upon ridge of bare or nearly bare rock separated by depressions, in places filled with scrubby timber, elsewhere occupied by clear-watered lakes of every size from mere ponds to bodies of water five or six miles or more in length. The open valley of the Yellowknife, famed as the route followed by Franklin—now constricted and occupied by stretches of narrow river, again widening and filled with considerable lakes—can be traced for miles till it disappears in the hilly country to the north.

From one of the highest hills on the western side of Lake Marian the low flat-topped ridge forming the edge of the Paleozoic rocks can be observed trending off northwestward, parallel to the valley of Marian River. Southeastward this ridge merges in the slightly elevated country forming the western border of the northern arm. While there are no conspicuous heights close to this shore, the country for the most part rises 100 feet or slightly more above the lake a short distance back from the water. Opposite Yellowknife Bay are extensive ridges of coarse sand, exhibiting the usual bizarre forms of moving dunes.

The water of the northern arm is shallow and generally fairly clear, excepting when strong winds blow from the south, but not of the limpidity of the eastern bays. Navigation is both difficult and dangerous on account of the large number and wide distribution of submerged rocks, many of them uncharted.

It requires the knowledge of a native of the northern arm to follow the sinuosities of its shore line. A mainland indented by innumerable bays is masked by such a mass of islands that it is often impossible to say whether one is actually thereon or merely on one of the islands separated from it by narrow channels generally shallow and marshy. Farther offshore is a veritable maze of islands rising a few feet above the water, with shoals whose location is commonly only apparent in stormy weather. Towards the points, the shores of the bays are generally of solid rock, often extraordinarily ice-polished. Elsewhere they are in places swampy or bordered by old beaches. The lake bottom is commonly composed of very sticky gray clay resembling rock flour. This is evidently the finest material brought down by Slave River and carried farthest in suspension.

In contrast to the opposite side of the northern arm, the western shore line is, relatively speaking, even and unindented. There are numerous bays, but they are broad and open; there are comparatively few islands, and the unquestioned mainland is plainly distinguishable from the open water. Low cliffs of Paleozoic rocks, wave-cut, appear in places close to the points. The bottoms of the bays tend to terminate in swamps or are extended inland in marshy lagoons.

Apart from Yellowknife River the most important stream entering the northern arm is the Marian, flowing into the northern end of the lake of the same name. The Marian drains a chain of large lakes forming part of the canoe route to Great Bear Lake, which closely follows the Paleozoic-Pre-Cambrian contact.

Origin of the Basin

While the coming into existence of Great Slave Lake is a recent geological event and is due primarily to interference with the conditions of drainage existing before the glacial age, the peculiarities of the outline of the basin, as also of many of the characteristic topographic forms, are due in part to causes much more ancient. Structure has had a decided effect in shaping many of the physical features of both land and water. Preglacial subaerial erosional sculpturing was the basis of relatively speaking minor glacial excavation.

In Pre-Ordovician times, the Pre-Cambrian rocks of Canada were very widely base-leveled by subaerial agencies. The surface upon which rose in turn the Ordovician-Silurian, Middle Devonian, Upper Devonian, and possibly later seas over what is now the western part of Great Slave Lake was of extremely low relief with only minor irregularities.[32] As the weight of sediments grew and the surface of the peneplain was tilted upward towards the east, renewed dissection of the land began. Prior to or concurrent with the Rocky Mountain folding the sea to the westward disappeared, and this newer land also came under the influence of subaerial attack.

By the period immediately preceding the advance of the Keewatin ice sheet, drainage was well established and, in much of what is now the basin of Great Slave Lake, was probably mature. It is difficult to establish assuredly the courses of even the larger preglacial streams, but many features suggest that a great river flowed northward close to the border of the Paleozoic and Pre-Cambrian rocks along or near the present valley of the Slave. While proof is lacking, there are certainly topographical reasons for believing that this preglacial river, instead of following the present course of the Mackenzie, may have continued northward along the contact as far at least as Great Bear Lake. Into this river from the west would have flowed the antecedent of Hay River with minor tributaries, and from the east a large stream formed by the union of a number of ramifying branches.

The nature of the sculpturing done by these preglacial streams would depend on the structure and the lithology of the underlying rocks, but even in the Pre-Cambrian it may be assumed there were broad basins—the result of long-continued erosion. Into this well

[32] Compare the Lake Athabaska region. See F. J. Alcock: The Origin of Lake Athabaska, *Geogr. Rev.*, Vol. 10, 1920, pp. 400–407; especially p. 404.

dissected region, with narrow ravines opening into broader depressions and these in turn into spacious valleys, advanced from the east the Keewatin ice sheet. The record of its handiwork shows today in disorganized drainage and modified land forms.

It is not the intention of this article to enter into the controversial subject of the extent of erosion by the Pleistocene glaciers. There is abundant evidence that the ice not only shifted vast quantities of detrital material but, after removing the products of decomposition, polished and striated even the hardest rocks below, as is so well shown around Great Slave Lake. Thus, apart from actual removal of solid rock, the glaciers are believed to have gouged and deepened the aggraded valleys. Erosion of solid rock was probably selective. Softer or shattered material along fault planes or highly schisted shear zones would be susceptible to furrowing; the ridges of well jointed rocks to plucking. If the extent of erosion of solid rock were uniform it is difficult to explain how a mass of soft limestone, like the butte at the old site of Fort Rae, could have resisted the attack which has polished to the smoothness of glass the granitic rocks a short distance away. While there is no information available for gauging the extent of removal of solid rock by the ice, it may be assumed that the preglacial valleys, situated where the basin of Great Slave Lake now lies, were in many cases both widened and deepened.

Cameron, in his paper "Post-Glacial Lakes in the Mackenzie River Basin," has graphically described the progressive stages passed through by Athabaska and Great Slave Lake as the Keewatin ice sheet slowly withdrew to the eastward. The water of Great Slave Lake, impounded between the morainic material flung across the valley of the Mackenzie near the lake's present outlet and the retreating ice, rose until it flowed over the dam to the west or was captured by the advance of a tributary of the Mackenzie. In the first instance the presence of the ice and at a later period morainic dams would have prevented the reëstablishment of the presumed northerly drainage along the depression following the Pre-Cambrian-Paleozoic contact until the present outlet was well established.

Cameron, largely on the evidence of numerous closely spaced old beaches, believes that the differential postglacial elevation to the east and west of Great Slave Lake has had the effect of rapidly draining the great basin in the past and concludes that the movement is still in progress, as would appear from the beach lines built up in modern times. Meanwhile the rapid alluviation by the silt brought down Slave River proceeds—carrying the delta farther and farther into the central portion of the lake and distributing fine material almost to its remotest bays. The great lake is doomed to follow in the wake of other greater postglacial features and disappear or dwindle into insignificance.

AGRICULTURE AND SOILS OF PALESTINE

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WHILE there is probably no other country in the world that has been so thoroughly studied from archeological and historical viewpoints as Palestine, it is certain that in none of the civilized countries has there been such a complete neglect of subjects pertaining to agriculture.

Geological investigations indicate the practical absence of mineral wealth. A potential supply of potash and other salts in the water of the Dead Sea, together with small quantities of phosphate rock, sulphur, and bitumen, seems to cover the field of mineral resources. With the establishment of stable governments throughout Asia Minor, Palestine will derive material benefit from the development of commerce, a large part of which will doubtless cross the northern part of the country, en route to the port of Haifa on the Mediterranean coast. This prospective development will affect mainly the larger towns, contributing but little to the upbuilding of the remainder of the country. Practically devoid of mineral wealth, having no forests, and but limited possibilities for the development of hydro-electric power, Palestine must look, for any substantial increase in wealth and prosperity, to the development of her agriculture.

Palestine is not self-supporting with respect to her major food products, and only a few fruits and vegetables are produced in excess of local consumption. A study of the data presented in the Annual Report of the Department of Agriculture, Forests, and Fisheries for 1926[1] shows that the value of imports of all agricultural products exceeded the value of exported products by £E210,305 (£E = $5.00). If fruits and vegetables are excluded from the total, there was a net excess of £E618,587 of imports over exports. The condition of the world market will affect Palestine's balance of trade to some extent, but, until the country produces the greater part of her food supply, economic conditions will remain unsatisfactory. Agricultural land is the most important natural resource. It is vitally important that the character and distribution of the soils be ascertained and that the best methods of handling them, according to their specific adaptations and requirements, be determined and put into practice.

The beginning of agriculture in Palestine goes far back beyond the

[1] Annual Report, Department of Agriculture, Forests, and Fisheries, October 1, 1925, to September 30, 1926. Jerusalem.

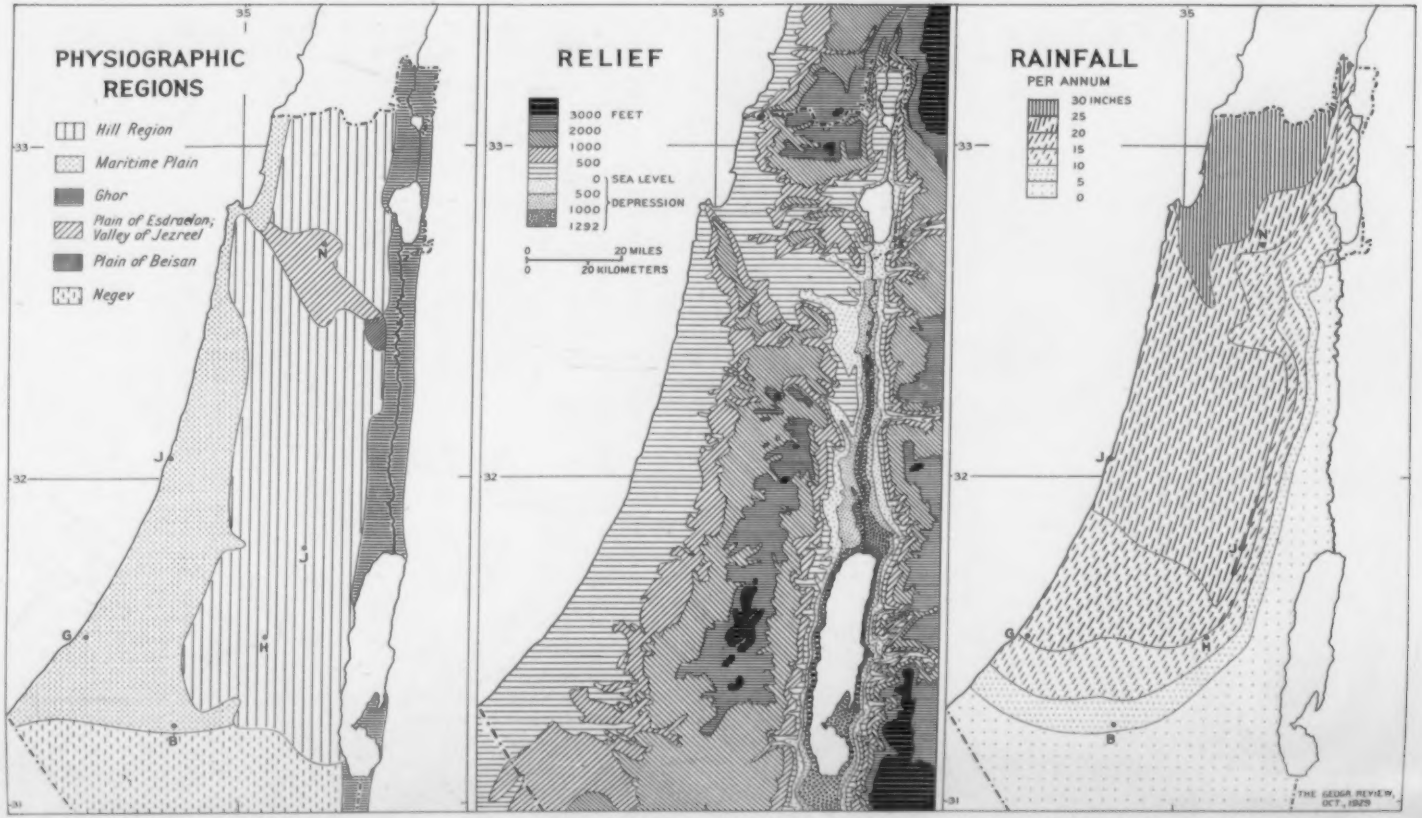


FIG. 1—Physiography, relief, and mean annual rainfall of Palestine, exclusive of the area of the Negev from latitude 31° S. to the Gulf of Akaba, a desert region, on which little information is available. Scale approximately 1 : 2,500,000. Compare Figure 4.

dawn of recorded history. The first records of invasion show that agriculture then was not greatly different from what it is today. The hills, although considerably better covered with forest trees than now, supported a fairly dense population that grew cereals, fruits, and olives over an area that was at least equal to that now under cultivation. In the Jordan Valley, irrigation works going back into remote antiquity indicate a far more extensive use of the land in those times than in recent centuries. History records the existence of date gardens, fields of sugar cane and cotton, and of a wide variety of tropical and semitropical fruits.

Numerous wars throughout the centuries resulted in a depletion of the population and the subsequent reversion of the land to something like its original condition or in the actual disappearance of cultivated areas by destruction of hillside terraces. Although Palestine has not suffered greatly from war for a long period now, she has been under the rule of aliens who have had but little concern for her material welfare, and the rural population has struggled along under conditions discouraging to any initiative. It is probable that the agriculture of Palestine was never at such a low ebb as at the close of the World War.

The present-day agriculture is that of cereal farming and "plantations," the term "plantation" being applied almost wholly to plantings of fruits and nuts, although it sometimes includes vineyards. The production of cereal crops is largely monopolized by Arab farmers, while both Arabs and Jews are engaged in fruit-growing. The production of vegetables is an industry of considerable magnitude in which all races are engaged, with the Arab farmer predominating.

Aside from a few localities where irrigation made possible the growing of any crop desired, there was, up to about the time of the World War, practically no recognized adaptation of crops to soils. Instead, centers around which definite types of agriculture developed were more or less unconscious responses to differences in rainfall. Barley, for instance, because of its ability to mature under conditions of lower rainfall than wheat, is largely grown in the region east of Gaza. Sesame is grown most extensively in the northern part of Palestine, where the average rainfall is 25 inches or more, and Indian corn (maize) appears in regions of similar rainfall. Olives, although grown throughout the length of the land, produce profitable yields with a rainfall of 20 inches or more, and the most thrifty groves occur in the hills of northern Galilee under a rainfall of 30 or more inches.

Since the establishment of the present government, extensive agricultural developments have followed in several districts, accompanying the employment of scientists trained in different branches of agriculture. The general adaptations of the principal families of plants to broadly defined soil conditions is well known and, to that extent, the general distribution of crops for the soils of the country

FIG. 1.—Physiography, relief, and mean annual rainfall of Palestine, exclusive of the area of the Negev from latitude 31° S. to the Gulf of Akaba, a desert region, on which little information is available. Scale approximately 1:2,500,000. Compare Figure 4.

can be worked out. With few exceptions, however, but little is yet known regarding the specific soil requirements of different varieties of the same crop, and the working out of a variety distribution is a task calling for a long period of study and investigation. The consideration of the use of the soils involves a recognition of the fact that the larger part of the crops must always be grown under low rainfall conditions and without irrigation.

FIG. 2—View from the tel of old Jericho, showing pool formed by large spring in foreground and irrigated area around the present town of Jericho, growing tropical and subtropical fruits and vegetables. Bananas are one of the principal fruits.

Throughout the hill regions cultivated areas are mainly adjacent to the villages, and the distribution of crops is more largely governed by topography than by character of soil. There is, also, a tendency among the communities to favor some one crop, although practically all varieties grown in the hills will be found to some extent in every district. Grain production is confined almost wholly to areas where cultivation is possible without resorting to terracing: grapes come largely from Hebron, apricots and peaches from the district between Bethlehem and Hebron; olives from Beit Jala, Ramah, Nablus, and from the north and west of Nazareth. The vegetable gardens of Ram Allah cover hundreds of acres, the country around Geba is noted for its figs, and pomegranates thrive in the region of Kfar Kanna, northeast of Nazareth.

The extent to which the Judean Hills and portions of the Samarian Hills have been used for cultivation, both in the past and present, is remarkable. A crop will be found growing during every season of the year wherever the soil is not too stony, nor the slope too steep for the native to use his wooden plow. Little plots of ground, of only a

few hundred square feet in area, have been searched out, and the winter and spring months find the steep hillsides dotted with grainfields of every conceivable shape and size.

When the population of the hills reached a density that compelled the utilization of slopes too steep for the usual methods of cultivation, terracing was resorted to, and the former extent of the terraces points conclusively to a period when the hills supported a rural population

FIG. 3—Terraced olive groves west of Jerusalem. Note the stone retaining walls to hold the easily eroded soil of these Judean Hills. Compare Figure 5.

considerably in excess of that of the present. Thousands of acres of the stone-walled terraces on the Judean Hills have fallen into decay or largely disappeared. With one exception, no evidence of an extension of the present terraced area has been noted, even in a few localities where it might be possible to construct new ones, and it seems probable that a rough balance has been established between the area of cultivated terraces and the number of persons available for their maintenance and cultivation. The residual soil of the hard limestone regions is very susceptible of erosion when not protected by natural vegetation or by artificial works; and, with the loss of the retaining walls, the soil is carried into the wadies, and the area that was once under cultivation can never be regained. In the Samarian Hills the soils are extremely resistant to erosion, and steep terrace slopes will stand indefinitely with only a protective cover of weeds and grasses.

Within the hill regions agriculture may not be expected to show any marked departure from that of the present in the matter of the varieties of crops, although a considerable improvement in yields and quality of fruits and vegetables should follow as it becomes possible to reach the native farmer with a campaign of education.

Throughout the lowlands of the country practically every acre of tillable land is used for some crop, cereals being the mainstay with lesser areas devoted to fruits and vegetables. For untold centuries the soil has been scarcely scratched by the wooden plow; each year's stubble is grazed to the very surface of the ground by successive herds of goats and camels, and nothing has been returned to the soil in the way of manures and fertilizers. As a result, the average yield of wheat in Palestine has fallen to a little less than nine bushels an acre, and that of barley to less than five bushels. Were it not for the fact that, other than for a possible outlay for seed, the prices received by the native farmer are practically all profit, not even he would be able to maintain an existence.

Experience shows that greatly increased yields are possible with thorough tillage and with the returning to the soil of organic matter either in the form of plant residues or stable manures. In the older German colonies, established more than a quarter of a century ago, such practices have raised the average production of wheat to as high as 20 bushels an acre, barley to 40 bushels; and the yields continue to show slow increases from year to year. In the more recently organized Jewish colonies,[2] where the soil has had but a few years of proper treatment and where conditions have often been none too favorable, the average yield of wheat has been brought to a little more than 11 bushels, individual fields have returned as high as 20 bushels, and the Arab's return of 5 bushels of barley to the acre has been exceeded by nearly fourfold.

Owing to the scarcity of water for irrigation, dry-farmed crops will continue to occupy the greater part of the tillable land of the plains and valleys; and, as the small grains can grow throughout the rainy winter and mature in the early summer, cereals will continue to be the principal crop. Vineyards and almonds have proved successful without irrigation; but their distribution is limited by certain soil conditions, and the acreage of those crops will be restricted to a number of well known districts. The native farmer can continue to exist upon the yields he ordinarily secures from his dry-farmed crops, as his cost of production is low and his living of the simplest. In the production of such crops the outsider cannot compete, since his cost of production usually exceeds his returns. The production of cereal crops is, however, necessary; and, if the Jewish colonist is to maintain his hold on the land, living returns must be assured by the adoption of a plan of general farming that will include the production of forage crops,[3] vegetables, and dairy and poultry products.

[2] Cf. Andrée Choveaux: The New Palestine, *Geogr. Rev.*, Vol. 17, 1927, pp. 75–88.

[3] Investigations are under way on the production of fodder crops and their relation to a live-stock industry—a development urged by Sir John Russell. See his "Report on Visit to Palestine, April, 1928," published by the Zionist Organization, London (1929), with the authority of the Empire Marketing Board.

The zone of plantations is restricted by soil conditions and by supplies of water for irrigation. The extent of suitable soils is pretty well known, but the area over which adequate amounts of water can be secured is probably less than that of the soils. Within the zone of plantations the outsider has proved his ability to compete with the native. Here the two are placed upon a more nearly equal basis, so far as cost of production is concerned; and, by reason of greater initiative and adoption of modern methods of tillage, the outsider is enabled to secure higher yields and a better quality of produce. Also, he is beginning to improve his methods of packing and marketing. All of these, in years of favorable yields and prices, give him a return that makes his net profit far exceed that of the native farmer.

The Soils of Palestine

The hills of Judea, Samaria, and Galilee are composed largely of hard, impervious limestones and a softer chalk, with considerable areas of basalt to the east of the main watershed of the Galilean Hills. To the west the formations dip beneath strata of marine deposits (Tertiary, mainly Upper Pliocene and Pleistocene) and alluvium, and to the east where they have been dropped down in the Jordan-Dead Sea depression they are buried beneath lacustrine and alluvial sediments of unknown thickness.

The harder limestones comprise the greater part of the Judean Hills from near Hebron northward to the vicinity of Ram Allah and underlie a part, at least, of the chalk of the Samarian Hills. The latter are composed very largely of the softer limestone, and this formation also flanks both the eastern and western slope of the Judean Hills. Lower Galilee, or that portion west of Nazareth, is made up largely of the softer chalk; and north of a line drawn from Ras en Naqura towards the northern end of Lake Tiberias the harder limestone prevails. The larger body of the basalt extends easterly from near Nazareth across the Jordan River and from the Valley of Jezreel northward to about the northern end of Lake Tiberias.

Throughout the hill regions slopes are prevailingly steep, the erosion of the surface soil is continuous, and fairly young materials are constantly exposed on the surface. Structure zones are absent in the profiles of the soils, free lime is uniformly distributed, and the subsoils are only slightly more compact than are the surface soils. Being immature, the characteristics of the soils are dominated by the parent material; within the areas of the different formations there seem to be no marked differences in the chemical composition of the soils, and there is a marked uniformity of texture and color. From north to south the color of the surface soils becomes progressively slightly lighter, although that condition is not very striking.

The harder limestone lies in nearly horizontal beds, which are in only a few places sufficiently massive to form cliffs, and the slopes of the valleys usually consist of narrow rock terraces. Throughout the central part of the Judean and Samarian Hills, from about Hebron northward to a short distance beyond Ram Allah, the top of the range is marked by rather extensive areas having smooth surfaces that are not so steep as to prevent planting and cultivation without terracing. Local watershed divides, however, are prevailingly narrow. Throughout this region the wadies lie in deep, often canyon-like, valleys whose sides can be cultivated only when well terraced. No important areas of bottom lands are developed along the watercourses, and in many places the streams occupy truly V-shaped valleys. The mantle of residual soil is, commonly, very thin, and there are but few areas where considerable amount of labor is not necessary to remove the loose stones before cultivation is possible. In many places numerous small contiguous fields are separated by stone fences built of fragments gathered from the surface, and the amount of stone remaining is a great inconvenience to the farmer. The residual soils are stiff, heavy-textured, dark reddish-brown, very calcareous clays. These soils are very tenacious when wet but crack deeply upon drying.

In the areas of the softer limestone, or chalk, the formations have weathered deeply, resulting in porous, calcareous, gray silty soils that are without evident change in texture from the underlying rock. The surface soils are friable; and the subsoils, although porous and but slightly compacted, will, in undisturbed exposures, resist erosion for long periods. The prevailing color of the surface soils is gray, and the appearance of the chalk area is lighter than the remainder of the hill region. Considerable areas of transported soils are present along the larger wadies, either as long, gentle slopes extending to the axis of the valleys from the bases of the enclosing hills, or as lower, flatter areas within the flood plains of the streams. These soils are predominantly calcareous clay loams, brown in color, and locally contain considerable amounts of fine gravel and small stones. Although derived wholly from the gray residual soils on the hill slopes, the transported materials under somewhat moister conditions have acquired darker colors through the accumulation of organic matter from a cover of grasses and weeds. The soils are still in the stage of youth, and there is no apparent leaching or segregation of lime nor the development of structural horizons. Within the chalk areas the contours of the hills are more rounded than within areas of the harder limestone, and terracing of the slopes is not so common. West of Nazareth the slopes are rolling to steep, crests of elevations are well rounded, and a very considerable part of the surface is not too steep for some type of agriculture.

Within the area of basalt the topography changes mainly to hori-

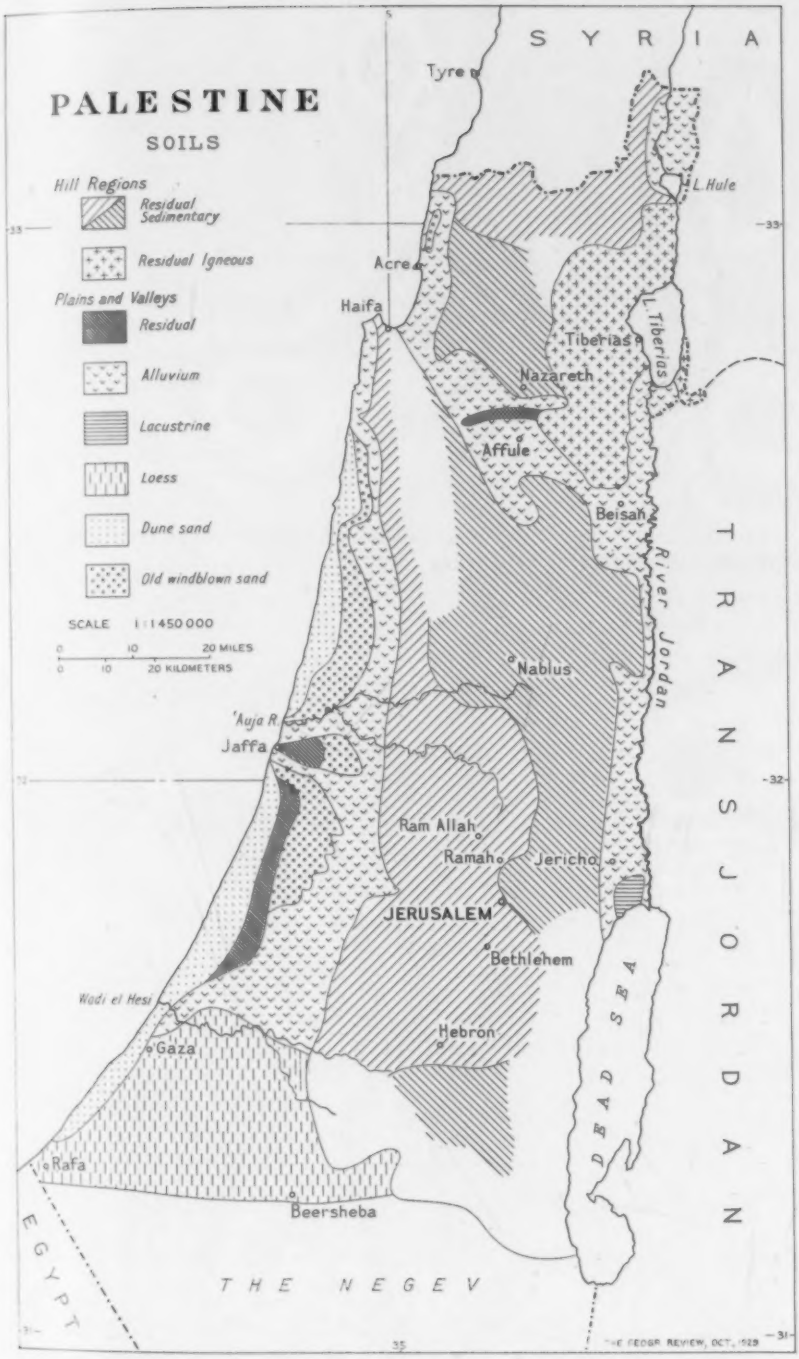


FIG. 4—Soil map of Palestine. Compare the classification on pp. 601–602. Scale approximately 1:1,500,000.

zontal, broadly sweeping plateaus where major differences in elevation are commonly steplike. Canyons and stream depressions are deep and narrow with steep to vertical sides. All this is in such marked contrast to the sharply uneven topography within areas occupied by sedimentary formations that it forms one of the striking features of the country.

Much of the basalt in eastern Galilee and in the Plain of Esdraelon has weathered to depths of several feet, giving rise to very dark reddish-brown to maroon clays. Along the edges of escarpments, on some of the steeper slopes, and on the crests of elevations erosion has about kept pace with the process of rock weathering, and the parent basalt is often at a depth of less than 12 inches below the surface. All of these soils shrink considerably upon drying, and cracks very commonly extend to depths of six or more feet. This characteristic is not wholly undesirable, as the soils in plowed fields usually acquire a finely divided structure without an unusual amount of cultivation. In the regions occupied by the basalt the alluvial soils are so similar to their parent residual soil that a distinction between the two is possible only where topographic forms clearly indicate the mode of development.

Soils of the Maritime Plain

In the Maritime Plain the soils present such a complexity as to origin, formation, structure, and drainage that only a few of the outstanding features can be given much consideration.

The oldest soils on the plain have been derived from the weathering of a series of old marine clays (Eocene) that have been tilted and uplifted to form the elevated portion of the plain east of Gaza. The parent material is a succession of gray, brown, and reddish-brown stratified clays. These are highly calcareous, and nodules of lime and incrustations in seams and cavities are of not uncommon occurrence. The soil that results from the weathering of these clays is a grayish-brown clay loam or clay. The structure is compact, free lime is always present, and nodules and concretions are usually abundant. Where the surface has been broken erosion is active, and a typical badland topography has been developed over a large area southeast of Gaza. The areas of this soil, together with that of the loess, lie between Beersheba and Wadi el Hesi and form the most elevated section of the Maritime Plain. The general surface elevation is not far from 500 feet above sea level, and a number of prominent ridges north of Beersheba attain elevations of nearly 1000 feet.

A thin mantle of loess, overlying the old stratified clays, extends from about Wadi el Hesi southward for an undetermined distance into the Negev. The thickest exposure noted was in a wadi bank, some 15 miles southeast of Gaza, where about 20 feet of fine, buff-colored

FIG. 5

FIG. 6

FIG. 7

FIG. 5—In the Samarian Hills the porous soils are little subject to erosion. The fronts of the terraces are protected only by growths of weeds and grasses.

FIG. 6—Stone walls for fences on the stony fields of the Judean Hills.

FIG. 7—Basalt soils in southern Galilee, east of Nazareth. The flat topography contrasts sharply with the steep hills and deep narrow valleys of the limestone areas.

wind-laid soil had accumulated. Much of the loess is very thin, and the underlying clays are often exposed in cuts along the Gaza-Beersheba highway and upon the narrow crests of ridges and elevations. Both the surface soil and the subsoil of the loess are a very fine sandy loam that is unchanged in either color or texture to a depth of more than six feet. The surface soils are porous and friable. The subsoils are so slightly compact that fragments offer but little resistance to crushing in the hand, and exposures show a faintly columnar structure. A shrinking and cracking—characteristic of the greater part of the soils of the plain—is not characteristic of this soil. This loess possesses that peculiar quality, which characterizes loess the world over, of maintaining vertical walls in exposures for long periods. The entire profile of the soil is slightly calcareous, and chemical analysis fails to show any noticeable concentration of lime at any depth below the surface.

A series of highly calcareous, stratified, coarse-textured sandstones extend as a narrow ridge along the coast from Gaza northward to the Syrian boundary. These sandstones, which were apparently continuous at one time, have been cut through by some of the larger streams passing to the sea, and large areas are now obscured by an overburden of wind-blown sand. The sandstones are very little resistant to weathering agencies, and their visible extent is marked by a succession of low, rounded hills and ridges having a topography not greatly unlike the bordering areas of wind-blown sand. The soil resulting from the weathering of the sandstone is coarse-textured, porous and leachy, and of a light gray color upon elevations and steep slopes but of a dark gray to brown upon lower slopes and in depressions where better moisture conditions have favored an accumulation of organic matter. Upon crests of elevations the parent rock lies close to the surface, and fragments of the soft sandstone occur throughout the soil. At lower elevations the sandstone is usually more than six feet below the surface, largely because of the transportation of the residual soils down the slopes. All of the soil is highly calcareous, with the lime apparently having a very uniform distribution.

Wind-blown Soils of the Maritime Plain

The wind-blown soils constitute the most important area of soil on the Maritime Plain from an economic standpoint, and they present some features with respect to chemical and physical composition that are unusual and not yet fully understood. These sands consist both of materials that are still in the process of accumulation and of materials that have been long in place.

The recent sands are almost continuous along the length of the Mediterranean coast, where they form extensive areas of mobile

dunes. Picturesque as dunes may be, they are undesirable neighbors in an agricultural region. Moving slowly and irresistibly inland they are burying productive citrus groves and vineyards in many places and, in others, lands well adapted to the production of dry-farmed cereals and to grazing. Futile attempts toward arresting the movement of the sand have been made in a number of places by planting trees along the lee side of the dunes. This simply retards the movement for a short period and is far from being an effective method of control. Although some work has been done by the government to control the march of the dunes, the task seems almost insurmountable; and a very considerable area of agricultural land is certain to be destroyed in the near future.

FIG. 8—Typical profile of old reddish wind-blown sands (Deiran series) on the Maritime Plain. The substratum is a yellowish, nearly structureless fine sand that is mildly calcareous. The surface soil and subsoil are noncalcareous or slightly acid and are the only soil materials in Palestine possessing that characteristic.

The older wind-blown materials, immediately to the east of the recent dunes, are not only a striking feature of the physiography of the plain but possess marked differences in crop adaptation and are, when measured by potential crop returns, the most valuable soils in Palestine. They represent accumulations of wind-blown sand which have been stationary for so long that weathering has developed pronounced changes in color, texture, structure, and chemical composition. The surface soils are, prevailingly, light reddish-brown loamy sand, although they are locally loams and are locally brown where conditions have allowed accumulations of organic matter from a grass cover. This brown surface is from two to four inches thick and disappears when deep plowing mixes the surface soil with the underlying material. The subsoils are dark reddish-brown to maroon in color, are slightly heavier in texture than the surface soil, and possess a slight compactness which is sufficient to hold the sides of old war trenches in the position in which they were dug. The color, texture, and structure of the subsoil extend without evident change to an average depth of about eight feet, when it is abruptly underlain by a substratum of fine yellow sand that is without evident structure. Soil and subsoil are noncalcareous, and the substratum is only slightly calcareous. The condition is of unusual interest as this is the only soil formation in Palestine that is lacking in an abundance of free lime.

The above-mentioned conditions of color, texture, and structure characterize the greater part of the soils within the area of this formation, but there are a number of more or less local conditions which govern the value of the soils for agriculture. Most widely developed in the Plain of Sharon is the compacted stratum termed "nasaz" by the native farmers, which practically obstructs subsoil drainage and effectively limits the penetration of the roots of cultivated crops. This stratum is dull grayish-brown to light reddish-brown in color and is brilliantly mottled with splotches of red, yellow, and black. The texture of this material is seldom heavier than a sticky loam, and sandy loam and fine sandy loam textures seem quite prevalent. The structure is peculiarly compact and, although not wholly impermeable, greatly restricts the movement of moisture; and the overlying soil remains wet for long periods after rains or irrigation. Nasaz occurs at an average depth of about 30 inches below the surface, although in very restricted bodies it will be found practically at the surface. Its thickness is a foot or more, and occasionally it will extend to depths of more than six feet.

Not enough is yet known as to the relation of nasaz to topography to afford a basis for predicting its presence. It seems probable that its most usual occurrence is along small wadies or on adjacent slopes, although it is occasionally found upon the tops of knolls 25 feet or more above the streamways. Its extent cannot be given at the present time. Certainly it is most abundant in the district north of the 'Auja River, but it has been encountered as far north as Benjamina colony and for a distance of at least ten miles south of Jaffa. The condition of impeded drainage and restricted zone for root development absolutely precludes the satisfactory development of orchards and vineyards; and, as such crops are ordinarily very profitable, a careful survey of the soils of this group solely for the purpose of determining the extent of the nasaz would seem a worth-while undertaking.

An equally important condition, but one which is localized and apparently of limited extent, is the presence of a dull-gray clay, of very compact structure which contains small, hard, rounded calcareous concretions uniformly distributed to a depth of more than six feet. So far as is known, this condition occurs only in a few places in the vicinity of Raanana, west of the Arab village of Kfar Saba. Such bodies of soil have no value, other than for a scanty grass cover that affords some grazing. The origin of this condition is not known. However, it bears some resemblance to the compact marine sediments east of Gaza; and, although that material has not been identified in the central portion of the Maritime Plain, these bodies of clay open up a field for conjecture as to the area once occupied by the marine deposits.

The remainder of the soils on the Maritime Plain consist of water-

laid materials brought down from the hill regions. They are neither mature nor recent. In no case have they reached a stage of development where the surface soils have lost an appreciable amount of lime, nor are there any evident segregations of lime at any depth. With the exception of narrow areas along the base of the hills, where there are annual accretions of eroded material, all the soils have been in place long enough to have lost the colors of their parent residual soil and, where well drained, show something of the influence of the variation in rainfall in the different portions of the plain. In the vicinity of Wadi el Hesi, where the annual rainfall is about 15 inches, the surface soils are light brown in color and the subsoils only slightly darker. The rainfall increases rather uniformly northward, and with this increase the soils become brown, then dark brown, and finally almost black in the vicinity of Haifa and Acre.

Tentative separation of the older from the more recently deposited waterlaid soil can be made only on the basis of differences in topography, as there is no marked difference in either chemical or physical properties. In many places typical flood-plain forms are strongly indicated.

The surface soils of the recently deposited material consist of loams, silt loams, clay loams, and clays; and the subsoils are predominantly clays with recognized areas in the southern part of the plain where subsoil textures are not heavier than silt loams. Gravel is ordinarily present only along the base of the hills, but in the northern part of the plain a few of the larger wadies have carried a burden of small stones and gravel well out toward the coast.

Drainage conditions are generally good, excepting for comparatively limited areas of swamp and marshland near the coast, due either to the inability of the stream to maintain its channel to the sea through the shifting dunes or to the low elevation of the flood plain of the stream. Traces of soluble salts are usually present in the soils in such locations: excessive amounts occur only in the marsh along the lower reaches of Nahr ez Zarqa and in a few isolated areas northward along the coast for a distance of some six or seven miles.

Esdraelon, Jezreel, and Beisan

The residual soils within the Plain of Esdraelon are largely coincident with a broad, low ridge extending from the western end of Jebel Duhi across the valley to near the Hill of Megiddo. The parent material is a fine-grained basalt which, in weathering, gives rise to a very dark reddish-brown calcareous clay. This soil is seldom as much as six feet in depth and over considerable areas does not exceed two feet. Soils derived from the weathering of sedimentary formations are of limited occurrence and of little importance.

The parent material of the alluvial soils of the plain consists of the products derived from the weathering of both sedimentary formations and from basalt. Only in local areas, as on a number of alluvial fans, has the soil been derived wholly from one or the other of those formations; the greater part of the soils of the plain consist of undifferentiated materials from both sources. The soils on the Plain of Esdraelon have developed under a more abundant rainfall than have most of the other alluvial soils of Palestine and are prevailingly darker-colored, heavier-textured, more sticky and tenacious when wet and apparently have a greater moisture-holding capacity. During the latter part of the summer of 1927 it was noted repeatedly that these soils were definitely moist below a depth of about 20 inches, while the soils on the Maritime Plain contained barely perceptible amounts of moisture. Although the greater part of the soils of Palestine shrink and crack on becoming dry, that condition is most strongly developed in the Esdraelon. The cracks are of unusual width, a depth of at least six feet is common, and cracks nine feet deep were observed in a number of places. Only when these soils are deeply and thoroughly tilled is the separation of the subsoil reduced or wholly overcome.

The alluvial soils of the plain are brown, dark-brown, or black calcareous clays, and the subsoils are prevailingly dark-brown and dark reddish-brown compact clays. These are calcareous, but there has been no evident segregation of lime at any place in the profile. Differences in the colors of the surface soils are closely associated with differences in local drainage. West of Affule and southwest of Nahalal considerable areas have flat and uniformly surfaced slopes, and the soils in those districts remain excessively wet for several months of the year. In such areas the surface soils are black. Where there is better drainage, the surface soils are brown to reddish brown.

The Plain of Esdraelon and the Valley of Jezreel form a continuous depression extending transversely across Palestine. The soils throughout the length of these districts differ in no respect in the character of their parent materials or in mode of formation, but where drainage is normal there is an observable relationship between the colors of the surface soils and the rainfall. With an average annual precipitation of 20 inches or more a dark reddish-brown color predominates; with a decrease in precipitation lighter colors become apparent, and under a rainfall of about five inches, near Beisan, pale reddish-brown to grayish-brown soils are the rule. Exceptions occur in areas of less efficient drainage, as in the flood plain of the Jalud River or on alluvial fans where recently deposited materials have not yet been affected by local climatic conditions. In the Valley of Jezreel the alluvial soils are predominantly clay loams, reddish brown in color and highly calcareous. Small amounts of soluble salts are present in the soils in the eastern part of the valley.

The Plain of Beisan is a roughly rectangular-shaped area situated in an embayment between the base of the Samarian Hills and the Jordan, south of the Jalud River. The soils are probably wholly alluvial, in that they are composed of débris brought down by streams draining the eastern slope of the Samarian Hills, although it is possible that there are areas having soils derived in part from the weathering of old lake-laid materials. The surface soils are predominantly dull grayish-brown silt loams which are highly calcareous and often contain small amounts of alkali. The subsoils are similar or somewhat lighter in color and are either clay loam or clayey in texture. The plain is dotted with small springs, and near them the surface soils are black, high in organic matter, and excessively wet for much of the year. The alkali is not present in sufficient amounts to be dangerous, unless overirrigation results in water-logging.

Soils of the Ghor

In the great Jordan-Dead Sea depression, which extends for nearly the full length of the eastern boundary of Palestine, the soils exist under both truly arid and nearly humid conditions. Large areas are swampy, some parts are subject to intermittent overflow, and in other parts drainage is good or excessive. Near the Dead Sea the rainfall is about five inches during the winter months, and extreme dryness and heat are the rule during the rest of the year. Near the Syrian boundary the annual rainfall is about 30 inches, winter is moderately cool, and summer heat is extreme only for short periods.

At the northern end of the depression is the Hule region, a partially enclosed basin containing an extensive alluvial plain, the large Hule Marsh, and Lake Hule. The alluvial soils on the plain are largely reddish-brown clay loams derived from both igneous and sedimentary formations. They are calcareous but without structural horizons or concentrations of lime. The soils within Hule Marsh are not accessible, but around the margin they are black, slightly calcareous, heavy-textured silt loams containing large amounts of organic matter. The soil is submerged throughout the year and covered with a dense growth of papyrus and other water-loving plants. The alluvial plain is slowly encroaching upon the marsh through the deposition of stream sediments, and the marsh is slowly reducing the area of the lake as vegetation keeps pace with the shoaling of the water.

A high rocky plateau intervenes between the Hule region and Lake Tiberias. Here outcropping masses of both limestone and basalt form a rolling to broken surface; and the soils, wholly residual and commonly thin, are of little agricultural worth.

With the exception of the Plains of Gennesaret and Semak, Lake Tiberias is closely hemmed in by the cliffs of the basalt plateau of

eastern Galilee and by those forming the eastern boundary of the plateau that comes down from Transjordania. Recent alluvial sediments form the plain of Gennesaret. These are friable, dark-brown, gravelly, heavy-textured loams underlain by subsoils that are clay loams containing varying amounts of waterworn gravel. The soil on the Plain of Semak is the most northerly known representative of a series of lake-laid sediments that extend southward beyond the Dead Sea. The elevation of this body of soil at Semak is about 15 feet above the usual level of Lake Tiberias, and this would indicate the probable presence of similar soils around the shore of the lake. No areas have, however, been so far identified. The surface soil is a porous, friable, grayish-brown silt loam. The subsoil, to an average depth of more than six feet, is similar in texture and color, but the structure is somewhat more compact than that of the surface. The substratum is a series of thinly stratified, partially consolidated sediments that range in texture from fine sand to clay. Small amounts of soluble salts are rather uniformly distributed throughout both surface soil and subsoil, but the amounts are not dangerous unless drainage becomes obstructed.

South of the lower end of the Plain of Semak the hills close in on both sides, and the Ghor is narrowed to a strip of uneven and eroded land extending southward nearly to the mouth of Wadi Abu Sidra. From this wadi southward the Ghor gains increasing width and reaches a maximum of about 12 miles near the northern end of the Dead Sea. Throughout this extent the soils fall into two main groups: those derived from the weathering of old lacustrine sediments and those on the more recent alluvial fans. The latter constitute the long uniform slopes that sweep from the base of the hills toward the axis of the valley. The surface soils are clay loams and loams, light reddish-brown in color, strongly calcareous, and often contain considerable amounts of stream gravel and small stones. The thickness of this alluvium decreases rapidly with distance from the hills, and the subsoil is largely made up of lake-laid silts and clays. The surface soils do not often contain sufficient amounts of soluble salts to affect cultivated crops, but the subsoils are usually heavily charged with alkali—largely sodium chloride. The areas of these soils in which there is not too much alkali to prevent cultivation is confined to a relatively narrow strip along the lower slopes of the hills. The rest of the soil is worthless for all forms of agriculture.

The old lacustrine sediments occupy a large area north and west of the Dead Sea. These are grayish, heavy-textured materials, largely clays, containing alkali salts and gypsum in such quantity that crystals are commonly visible in the stratifications. The soil, resulting from the weathering of these sediments, is a gray to dark-gray clay with local inclusions of soils of lighter texture. The subsoil is of similar

FIG. 9

FIG. 10

FIG. 11

FIG. 9—In the background rolling hills of residual soils (Belain series), derived from a coarse-textured, calcareous sandstone. In the foreground old reddish wind-blown sands (Deiran series) with a new planting of citrous trees.

FIG. 10—The lacustrine sediments (Dead Sea series) in the lower Jordan Valley erode easily, and considerable areas have a badland topography.

FIG. 11—The Ghor west of Jericho. Wadi Kelt, in the center, drains a large area in the Judean Hills but is dry for almost the entire year.

texture but is mottled with reddish and yellowish streaks. The surface soil has a thin, moderately firm surface crust and is underlain by a granular subsurface mulch caused by the large amount of alkali salts that are present. The subsoil and substratum are compact. Large areas of this soil are barren, and none of it has any agricultural value whatever. The soil erodes rather easily and tends to development of a badland topography.

Although of no economic importance, it would be interesting to know at what point, during the decrease in the size of the sea, the dissolved salt content of the water became markedly saline. Analysis of the sediments in the Plain of Semak shows a soluble salt content ranging from about .3 to about .5 of 1 per cent. At Wadi Abu Sidra, where the valley again opens out, the soluble salt content of the sediments is rarely less than 1 per cent and occasionally as high as 3 per cent. At some point between the lower end of the Plain of Semak and the wadi it should be possible to determine the horizon at which the lake water began to accumulate rather large amounts of dissolved salts.

The Negev

The Negev literally means the "Southland" and is used here to include that part of Palestine south of a line east and west through Beersheba. This division is purely arbitrary. There is little information concerning this region, a desolate, arid land without permanent habitation. Occupied by the nomad Bedouin and his herds of camels during the rainy season, it is practically abandoned during the summer and fall when the herds move north in search of new pasture. The topography is a more or less disconnected system of hills, mountains, sandy plateaus, and intervening wadi depressions. There are no permanent streams; but the wadies, dry for almost the entire year, are occasionally torrential in their discharge after unusually heavy, and rather rare, rains. Practically nothing is known of the soils in the Negev other than that they are prevailingly sandy in texture, that there are areas of loess of undetermined extent south of Gaza, and that considerable areas are occupied by moving dunes.

Classification of Soils

Reconnaissance of the soils resulted in the establishment of several broad groups according to origin and formation. It is recognized that each of these groups contains soils that vary widely, not only in physical features but also in chemical composition and in value for crop production. Determination of the location, extent, characteristics, and utilization of these varieties can be made only by systematic and intensive study. The broad classification, resulting from several months of field work, is as follows:

1. Residual soils
   - A.* Hard limestones, principally in the Judean and Samarian Hills
     - a. Reddish clay soils; very stony; rolling hills and ridges; calcareous; soils often shallow: Judean series
   - B.* Soft limestone, or chalk, principally in the Samarian Hills
     - a. Gray silty soils; porous; calcareous; stones usually not abundant; rolling hills and ridges: Samarian series
   - C. Basalt in Galilean Hills and Plain of Esdraelon
     - a. Very dark reddish-brown clays; compact; calcareous; moderately rolling: Adamah series, 7600 acres**
   - D. Soft, coarse-textured, calcareous sandstone in Maritime Plain
     - a. Grayish to light-brown coarse sandy loam; soil often shallow and leachy; very calcareous; rolling hills: Belain series, 24,100 acres

2. Alluvial soils

   2a. Moderately old alluvium
   - A. Undifferentiated sedimentary formations
     - a. Light to dark reddish-brown clay loam and clay; poor surface crust and mulch development; no development of subsurface or subsoil layers; uniformly calcareous; locally stony and gravelly; drainage good; moderately rolling ridges; Maritime Plain: Shahmeh series, 185,800 acres
     - b. Light-brown to light reddish-brown loams and clay loams; uniformly calcareous; locally gravelly; subsoil drainage often restricted; locally excessively alkaline; gently sloping ridges and alluvial fans; Jordan Valley: Jericho series, 38,000 acres; Jordan series, 6700 acres
   - B. Basalt
     - a. Dark-brown to maroon clays; deep and well drained; calcareous; no development of soil layers; soils crack deeply on drying; Plain of Esdraelon and Valley of Jezreel: Tabaun series, 12,200 acres
   - C. Mixed origin—sedimentary and igneous formations
     - a. Dark-brown to black clays; calcareous; locally poorly drained; free from alkali; soils crack deeply on drying; smooth to gently rolling; Plain of Esdraelon and Valley of Jezreel: Affule series, 54,400 acres; Tel Thorah series, 16,600 acres; Beth Alpha series, 1800 acres
     - b. Gray to dark grayish-brown loams to clay loams; very deep or underlain by partly consolidated strata of lacustrine sediments; locally slightly alkaline; drainage fair to good; Plain of Beisan: Beisan series, 5900 acres

   2b. Moderately recent alluvium
   - A. Undifferentiated sedimentary formations from hill regions
     - a. Brown to dark-brown clay loams and clays; calcareous; surface flat; drainage good to deficient; alkali in restricted districts; Maritime Plain: Sakia series, 86,400 acres
   - B. Mixed origin—limestone, lacustrine sediments, and loess
     - a. Very light-brown to brown fine sandy loams to clays; calcareous; surface smooth; drainage good; no alkali; Maritime Plain: Saphir series, 47,400 acres; Imleih series, 41,600 acres

*Areas of *A* and *B* were not determined, as the field work did not go into any detail within the region of sedimentary formations.

**Includes only area covered by reconnaissance. Other areas occur in northern Palestine.

C. Mixed origin—sedimentary and igneous formations
a. Dark-brown to black loams and clays; calcareous; drainage good; no alkali; surface smooth; Jordan Valley: Gennesaret series, 2800 acres

3. Lacustrine soils
A. Mixed origin
a. Gray to light reddish-brown loams to clay loams; calcareous; drainage good to deficient; large areas highly alkaline, others free; Maritime Plain and Jordan Valley: Dead Sea series, 45,900 acres; Ruhama series, 37,700 acres; Semak series, 16,300 acres
b. Black silt loams very high in organic matter; slightly calcareous; drainage very deficient; Hule swamp: area not known

4. Wind-blown soils
4a. Recent deposits
A. Mixed origin
a. Yellow sand dunes along Mediterranean coast, 67,300 acres
4b. Old deposits
A. Mixed origin
a. Grayish-brown to reddish-brown sands to loamy sands; noncalcareous or but faintly calcareous; friable; drainage good to excessive; hummocky to hilly topography; Maritime Plain: Deiran series, 104,200 acres; Tumrah series, 15,300 acres

5. Windlaid soils—loess
A. Mixed origin
a. Very light-brown, or tan, very fine sandy loams to loams; slightly calcareous; subsoil very slightly compact; drainage good; no alkali; moderately rolling; Maritime Plain: Beersheba series, 158,800 acres

6. Undifferentiated series
A. Alluvial and wind-blown soils
a. Grayish-brown to dark-brown sand and clay; calcareous; friable to compact; drainage good; undulating; Maritime Plain: Shahmeh and Deiran series, 4500 acres
B. Alluvial and residual soils
a. Reddish-brown to maroon clays; calcareous; compact; drainage good; undulating to hilly; Jordan Valley: Tabaun and Judean series, 15,700 acres

The soil map (Fig. 4) shows the distribution of the major groups of the soils of Palestine according to their formation. The boundaries between the residual soils from sedimentary formations in the hill regions have not been determined; and, owing to the meager information concerning the Negev, no data are given for that region.

GEOGRAPHY OF A SUGAR DISTRICT: MARIEL, CUBA*

Robert S. Platt
University of Chicago

THE study here presented exemplifies a type of regional geographic work. It deals with what may be termed the pattern of human occupancy in a small district in a tropical agricultural region.[1] Mariel is one of the smaller ports of Cuba, shipping about one per cent of Cuban exports. In the district back of the port is the Central San Ramón, one of a hundred and eighty sugar mills in Cuba.

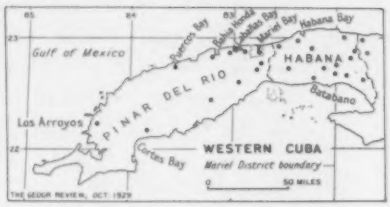


FIG. 1—Location of the Mariel district.

LANDSCAPE AND CANE DISTRIBUTION

West of Havana the first break in the rocky coast is at the Bay of Mariel. Around the bay is rolling lowland, farm country. East and south of the bay the lowland is bordered by an escarpment two hundred feet high, beyond which there is a plain at the higher level, somewhat broken to the east but smooth to the south. The district has an area of sixty-five square miles, of which about thirty-eight per cent is occupied by sugar cane.

There is no cane in a strip along the rocky exposed coast nor in the swampy land at the head of the bay nor on very steep slopes. Aside from these unfavorable areas most of the land is cultivable, and most of it has been cultivated at one time or another. Yet only about half of it is under crops at present. Most of the soil is brown silt loam, overlying limestone, but there are considerable differences in productivity, due to differences in slope and soil. Even where there are not obvious differences in soil type planters have classified their land from past experience, finding that some fields produce more than thirty tons of cane per acre and others less than fifteen tons the first year

* For invaluable assistance in making this field study special acknowledgment is due to Dr. Francisco José Velez of Mariel and Señor Norberto Sorhegui of Rio Hondo.

[1] Studies of a similar type by the author are: "A Detail of Regional Geography: Ellison Bay Community as an Industrial Organism," *Annals Assn. of Amer. Geogrs.*, Vol. 18, 1928, pp. 81–126; "Field Study of Republic, Michigan: A Community in the Marquette Iron Range," *Scottish Geogr. Mag.*, Vol. 44, 1928, pp. 193–204; "Pattern of Land Occupancy in the Mexican Plateau from Field Study of a Pueblo," to be published in a forthcoming bulletin of the Geographic Society of Chicago.

after planting. In each succeeding year the yield is about thirty per cent less than the year before until, after four, five, or six years, according to the soil, it is less than five tons per acre. Neglect of soil and delay in replanting, due partly to years of depression and restriction in the sugar industry, have reduced the average yield to less than twelve tons per acre.

Much poor land is left uncultivated, as being unprofitable in the present state of the industry. In addition, some good land is left uncultivated, to rest for at least one year after a series of cane-producing years and incidentally to provide pasturage for work animals. The proportion of land left uncultivated tends to be greater in less accessible areas than in those more favorably located.

Other Features of the Pattern of Distribution

Thus it appears that the distribution of cane production has obvious relations to land surface features. This geographic fact is a preliminary to the more complex geographic fact that the distribution of land control, production, transportation, population, and the whole human organization of the district forms an intricate pattern of human occupancy of the land.

This pattern is not determined by the natural environment. Many features are related only indirectly or historically to natural conditions, and some better adjustments might be made. Yet the pattern belongs definitely in its natural setting, meeting all the requirements of nature and accepting certain of the opportunities.

Property Division

In the development of the pattern land tenure is fundamental. The property division of today is unsatisfactory in many respects and might be called unnatural and poorly adjusted. Yet various weaknesses in the present were natural arrangements in the past, and their acceptance and gradual modification now are more reasonable than their complete elimination.

Property division began in the sixteenth century, when grants were made by the king of Spain. *Corrales* for stock raising were of circular form, one league in radius from a given center.[2] This system seemed natural and suitable at first. The country was empty and unknown; settlers were few and far between. The selection of a center was important, and the determination of boundaries unimportant. But when the country became populous the boundaries as well as the centers became important. The grants were faulty in location, difficult

[2] F. J. Velez: Geografía médico-sanitaria del Término Municipal del Mariel, Habana, 1927. On the general question of property division see also Ramon de la Sagra: Historia física, política y natural de la Isla de Cuba, Paris, 1842, Vol. 1, p. 230.

FIG. 2

FIG. 3

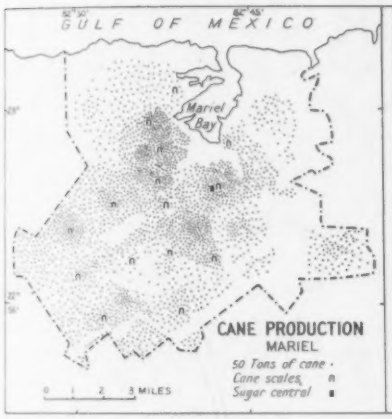
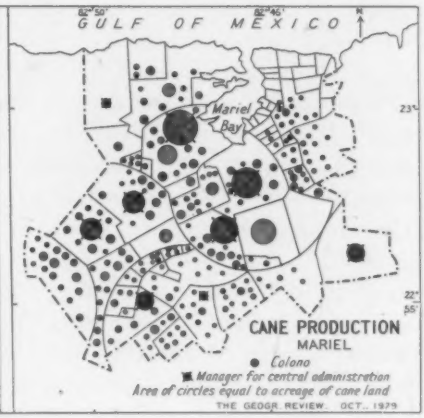


FIG. 4



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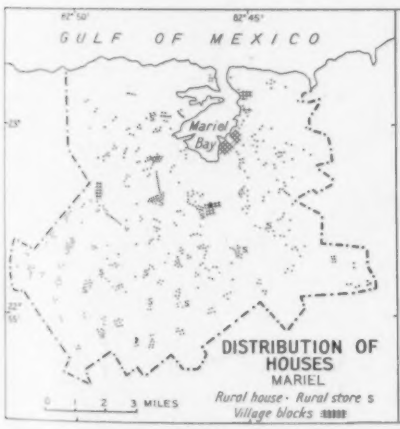


FIG. 6

FIG. 7

FIGS. 2 to 7—Sketch maps illustrating the distribution of property, cane production, population, and transportation in the Mariel district, western Cuba. In Figure 2 the first royal grant in the district is stippled.

to survey, impossible to harmonize, and too large to be occupied as units, each having an area of eighteen square miles. Confusion resulted. Gradually property was divided up, and boundaries were fixed by compromise agreements.

When the sugar industry developed, the circles were divided into new units—plantations based on the old property divisions but dimensioned to fit the new use of the area, located to contain several hundred acres of cane land, each plantation worked by slave gangs and served by its own sugar mill.

Now slave gangs have been superseded by free laborers, and small mills have been superseded by large centrals. These two changes have involved a readjustment of landholding in two opposite ways. A larger area of land is required by the central than by the small mills. At the same time the employment of free labor permits the effective working of smaller areas of land.

Accordingly there has been a concentration of landownership in a few hands. For instance, the owners of the Central San Ramón (a Cuban family controls and manages the company) hold forty per cent of the cane land of the district and have indirect control over the rest of the cane land. The Central San Ramón takes the cane from 16,000 acres, which formerly went to at least seventeen plantation mills.

Simultaneously for farm operations the old plantations have been subdivided into small tracts and rented to tenant farmers. In the Mariel district two hundred and twenty-five *colonos* produce cane, a majority of them on less than 20 acres, a few of them on more than 200 acres. Independent production is fostered by the central. The company maintains production on part of its own land and occasionally takes over other land from expediency rather than from choice.

Maps of one plantation, called the "Finca Mariel," serve to illustrate details of land division. The plantation is near the central and extends from swamp land near the bay to an outlier of the escarpment. It has an area of 970 acres, formerly operated as a unit with its own mill. Now it is owned as a unit but divided among twelve producers, one of whom is a manager appointed by the central.

The *colonias* of the Finca Mariel are from 10 to 450 acres in area, irregular in form, marked off by convenient but inconspicuous landmarks. Fifty-three per cent of the land is occupied by cane, five-sixths of it ready to harvest (1928), in irregular fields fitting into the landscape. Workers' houses are distributed conveniently in the *colonias*, with fruit and vegetable patches near by.

Distribution of Workers

Throughout the district rural population is distributed near cane fields. Each laborer lives and works in a small area, averaging eight

acres of cane per man—small enough for considerable grouping of houses without taking workers far from their fields.

The houses are simple structures, palm-thatched, well suited to the climate. They seem adapted even to the hurricanes which occur every three or four years on the average; because the relatively weak supports tend to give way and let the heavy roof sink to the ground and form a shelter for the occupants during the storm.

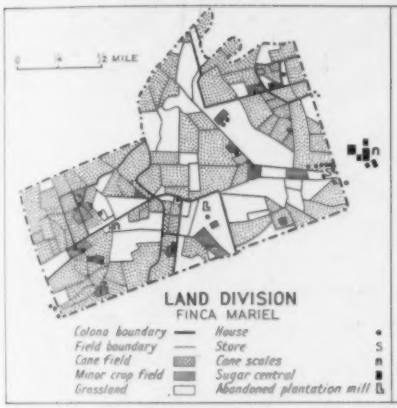


FIG. 8

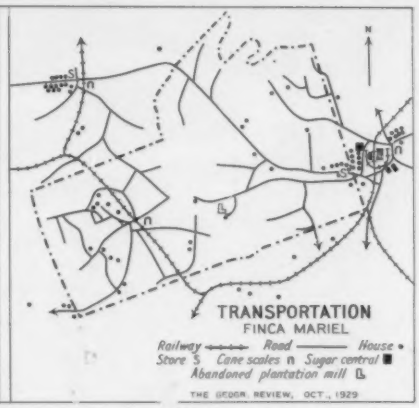


FIG. 9

FIGS. 8 and 9—Sketch maps illustrating agricultural economy and transportation in the Finca Mariel, one of the plantations of the Mariel district.

The house groups are on knolls, at crossroads, or at centers of old plantations, with some advantages natural or accrued, such as water supply and stores.

Among the people are white settlers or their descendants as well as black descendants of slaves. Almost a thousand families are on the land, in accordance with the intensive requirements of cane production. Of the labor in the industry at least ninety per cent is in the fields and ten per cent in the central, in contrast with the fact that of the capital invested in the industry hardly ten per cent is in the fields and about ninety per cent is in the central. The central itself is well designed to perform its function and is suitably located in the midst of its district.

SYSTEM OF TRANSPORTATION

The change from small mills to large central, drawing many little districts in to one large district, brought the inevitable need of a new system of transportation, to carry the cane crop of 160,000 tons to the central, a much greater distance, but just as quickly as to the old plantation mills.

The system of transportation is a vital feature of the pattern of

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Central San Ramón and near-by cane fields. Highway at right. Harvest time; men cutting along edge of standing cane, cart loading cane at right, oxen grazing on stripped leaves.

FIG. 11—Passageway for carts between cane fields. Such lanes serve for fire protection as well as for transportation.

FIG. 12—Boundary of the Mariel district. An old plantation boundary marked by royal palms; cart road along boundary.

FIG. 13

FIG. 14

FIG. 15

FIG. 13—Rural house. Built of local materials; roof thatch of royal palm leaves and siding of royal palm trunks.

FIG. 14—Cane cart stuck in mud in wet weather. In background, cane scales, unloading oxcarts, and loading railway cars.

FIG. 15—Tractor breaking sod of temporary pasture for cane planting.

land occupancy. A narrow-gauge railway reaches out from the central to the cane lands of the district and to the port. Its function is not to supersede the old oxcarts but primarily to connect the plantations to the central. Oxcarts continue to be an efficient means of bringing in the crop from the fields; but, instead of delivering their load to the plantation mills, they take it to the near-by cane scales, which have replaced the mills on the plantations.

The system includes the cart roads giving access to every field and focusing on the cane scales. The roads of the Finca Mariel illustrate the arrangement. The cane fields themselves are made small, averaging six acres, and are separated by passageways for carts.

The cane of each *colono* goes regularly to the most convenient scales. The traffic divides between scales, along *colonia* boundaries, are crossed by few roads but by a single stream of traffic on the railway. At the scales producers make delivery to the central, and the railway system is within the central organization.

Form and Limits of the District

Whereas the size of the district is related to the capacity of the central, the form and limits of the district are related to the layout and limitations of the railway, which is designed to reach available cane lands.

Good cane lands extend at a higher level south of the escarpment; but the railway seeks cane lands in the lowland and avoids the inconvenient ascent. Cart roads, however, ascend the escarpment; and, within the range of oxcart haulage, cane is brought down from the edge of the upland. Extension of the district southeast in the upland is favored by a motor highway permitting truck transportation in place of railway transportation to the central.

Thus the boundary of the district cuts across cane lands in the upland. Here is the divide between the flow of cane toward Mariel and that toward other centrals, south, east, and west.

The details of the boundary, depending on land control, follow the borders of old plantations, with lines and landmarks fixed in past history. The escarpment is a physiographic boundary; but for the topic under discussion the border of the district is the geographic boundary. The opposite sides of the boundary are similar in land forms, soils, and climate, but different in location in a pattern of land occupancy.

Functional Movements of the Pattern

The significance of location depends on motion: the pattern moves, and in its dynamic as well as its static form it harmonizes with the natural setting. The rhythm of the seasons (see Table I) impels the major movements. Ground is prepared through the year for planting

at the beginning or end of the rainy season. The cane grows through the rainy months. On fields just harvested it springs up again through the old leaves.

TABLE I—MEAN MONTHLY WEATHER DATA FOR MARIEL*

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Temperature (*degrees centigrade*)	20.9	21.0	22.5	25.0	25.4	25.9	26.3	26.6	26.1	25.2	23.0	21.4
Precipitation (*millimeters*)	17.6	54.6	45.5	56.9	128.3	191.2	142.6	169.4	169.5	199.0	79.8	61.9

* F. J. Velez: Geografía médico-sanitaria del Término Municipal del Mariel, Habana, 1927.

The operations of planting and cultivating, spread through the year or through several years, are leisurely compared with the great effort of harvesting the crop. Even when unrestricted legally, the harvest is confined to a period of little more than a hundred days in the dry season from December to April. The harvest begins at the end of the rainy season when the sugar content of the cane has increased to a point at which milling is profitable, generally above five per cent. It ends at the beginning of the rainy season when the difficulties of field transportation are too costly to make harvesting profitable.

The problem of harvesting northern hayfields is here multiplied many fold, by reason of the vastly greater product per acre, far harder to cut and hauled far greater distances. Oxcarts cannot operate in the mud, and it is difficult to devise any other economical method of wet-weather transportation. Even if tractors were obtainable, so numerous, so powerful, and so cheap that they could serve all the fields economically at all times, their use in the rainy season would be confined to a brief period before the decline of sugar content in the cane.

Harvesting in wet weather is complicated also by more rapid fermentation of cut cane, by greater injury to cane roots, and by greater difficulties and discomforts for field labor.

Confined to a brief period, the 16,000 acres of cane of the Mariel district are cut at a rate of over a hundred acres a day, by more than a thousand workers each cutting a ton and a half daily. The cane is transported immediately by more than a thousand oxen drawing two hundred and fifty carts, each taking daily two or three loads of three tons to the cane scales, to be carried on by a hundred cars to the central.

For a hundred days or more, work at the central is continuous. Day and night every ten minutes a carload is fed into the mill, or an oxcartload every two minutes.

The central is located to receive this inflow from the fields, and its location with reference to the outgoing product is less important—for only a fraction of the cane mass is transported away from the central. The water is boiled away; the crushed cane is burned for power and heat; a few cartloads of solid refuse are carried away to near-by fields as fertilizer; a small amount of liquid refuse runs to waste in a near-by stream; two or three truckloads of alcohol are sent daily to Havana; and the sugar product, about twelve per cent of the cane weight, leaves the central at a rate of one car every hour and a quarter, to be hauled to the port of Mariel and loaded, when ships come in, for export to the United States—seventeen thousand tons a year, about one half of one per cent of the sugar crop of Cuba.

Other Industries of the Mariel Pattern

The sugar industry forms only one part of the pattern of land occupancy at Mariel. Truck farming fits in with cane production. A fishing industry forms a distinctive pattern in the bay and streams and out in the Gulf. A great cement industry is concentrated in a little area of quarrying and manufacturing near the bay. A resort development extends along the shores, changing with the seasons. But these all belong in other chapters of the geography of Mariel.

NOTES ON A MAP OF THE LAGUNA SALADA BASIN, BAJA CALIFORNIA, MEXICO

Stanley W. Cosby
University of California

[With separate map, Pl. V, facing p. 620]

IN the northeastern part of the Mexican state of Baja California, almost adjoining the Imperial Valley, is the practically unknown Laguna Salada Basin.[1] While the two basins present close similarities of natural features, the dissimilarity between their economic development is notable. The Laguna Salada Basin is uninhabited; the Salton Sink has a population measured in tens of thousands. The one, occupying nearly a million acres, is practically unused; the other, slightly larger in acreage, has been the scene of one of the most rapid and spectacular developments in the whole history of irrigation agriculture. That important development has resulted in the creation of nearly $150,000,000 of property values with an annual production of agricultural commodities having a farm value of more than $25,000,000. Yet only thirty years ago the Imperial Valley region was a barren and uninhabited area, as the Laguna Salada Basin is today.

Of recent years Mexican officials interested in the economic advancement of their country have given much attention to reclamation possibilities. They recognize the need for thorough preliminary investigations covering not only the engineering aspects of the project under consideration but also other features that affect the economic success of such developments. The first investigation of this type was made in the Laguna Salada Basin during the winter of 1923–1924. Since that time a score or more similar studies have been conducted in connection with reclamation projects in other parts of Mexico.

One important phase of the investigation concerned the soils; the character of the various classes of soil was to be determined and the distribution of these classes plotted upon a suitable map. However, no such map, sufficiently accurate and detailed, was available; and the first need was for a survey of the basin and the preparation of a relatively detailed base map. In this work a closed transit and level traverse was made; beginning and ending at a known station in the city of Mexicali, this primary line extended longitudinally through

[1] Although various names have been applied to this basin in the past ("Laguna Maquata" by the U. S. Geol. Survey; "Pattie" by Sykes, etc.) it has officially been designated as "Laguna Salada" in the General Map of Mexico (1 : 2,000,000) published in 1924 by the Mexican Government.

the Laguna Salada Basin. From it, at intervals of three kilometers, secondary lines were run to the rougher areas at the base of the mountains. By aid of this grid the intervening topography was mapped by means of a plane table. From the plane-table sheets and other data acquired during the investigation, this article and the accompanying map, Plate V, have been prepared.

Physical History of the Basin

The Laguna Salada Basin, narrow and trough-like, is nearly separated from the main body of the Colorado River delta to the eastward by the Sierra de los Cucupas; on the north it is bounded by a high alluvial barrier along the International Boundary; and on the west and south by the rugged masses of the Sierra de Juarez and other mountains of the peninsular system. Like the thumb of a gigantic hand extending from the Gulf of California to the Salton Sea, the Laguna Salada Basin is connected with the main delta area at its southeastern end; at that point an eight-mile gap in the encircling heights opens toward the lower portion of the Hardy River, a distributary channel of the Colorado.[2]

The Laguna Salada Basin, like the near-by Salton Sink, is probably a former inlet of the ancient gulf that was subsequently dammed off by the advancing delta deposits. Alike in geologic history, these two basins have many physiographic similarities; the central area of each is composed of Colorado River alluvium, the gentle and almost imperceptible gradient of which extends downward from the delta distributary to a below-sea-level body of saline water at its northern end; in both, the central area is nearly surrounded by a wide band of sand dunes and piedmont slopes of coarser material that has had its origin in the adjoining mountainous regions.

Both of these basins, from a geological point of view, are of recent formation. Except for certain man-made obstructions—levees and similar works—the processes that have formed them would still be active. The Salton Sink, with these protective works, is no longer inundated; the Laguna Salada Basin without them is subject to periodic overflow. Whenever the river floods encounter the higher tides from the gulf, the Hardy River rises above its banks and a portion of its water flows down the sloping basin floor to the northern end. Although the inundations of the Laguna Salada Basin are relatively frequent, they vary greatly as to the time of occurrence and the volume of water that is diverted. Occasionally the basin floor is entirely covered with water; at other times the body of water has practically disappeared. These characteristic variations in the size of the Laguna

[2] For a map of the Colorado delta see Godfrey Sykes: The Delta and Estuary of the Colorado River, *Geogr. Rev.*, Vol. 16, 1926, pp. 232–255.

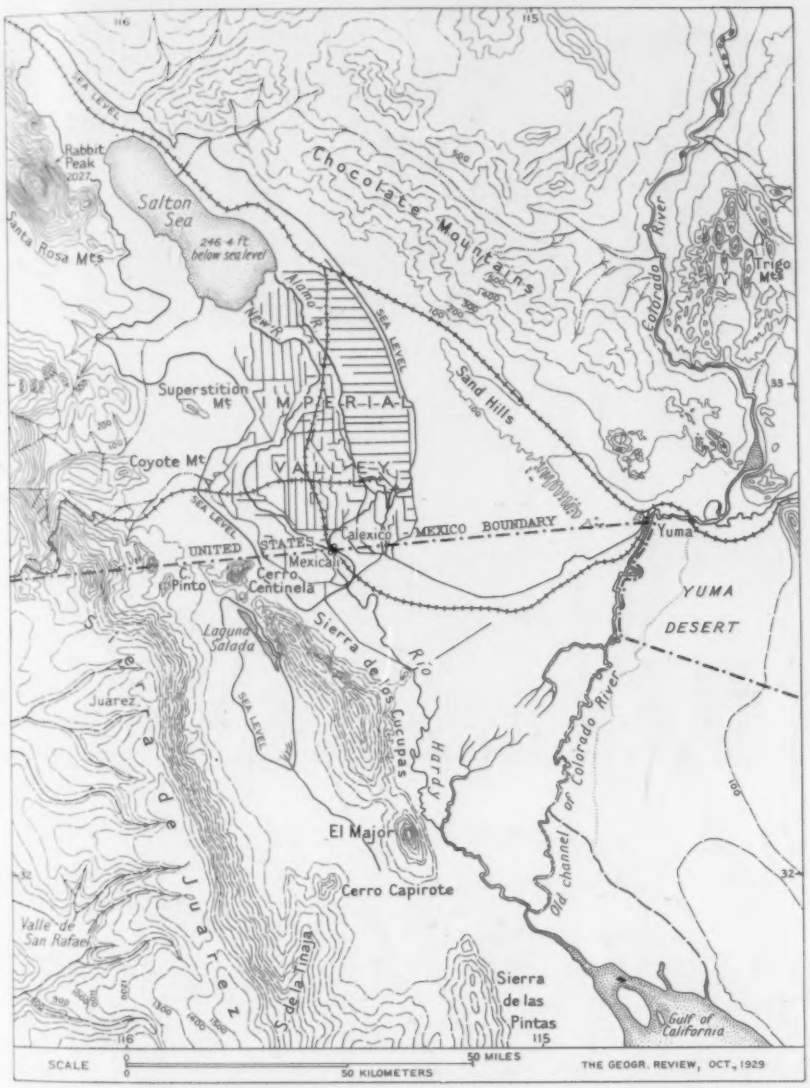


FIG. 1—Map showing the Laguna Salada Basin in relation to the Imperial Valley. The map is based in part on the Baja California-Norte sheet of the American Geographical Society's Millionth Map of Hispanic America. It is not possible to show the complete network of canals in the Imperial Valley, for there are 2000 miles of secondary canals in addition to three main canals; but its general character is indicated. Scale of map approximately 1 : 1,700,000.

Salada, as this body has been designated, have led some observers to differing and sometimes erroneous conclusions.

During the entire period of the writer's survey the greater part of the basin remained dry; the Laguna Salada had been reduced to a minimum size, and the central channel, or *barranca*, held but little

FIG. 2

FIG. 3

FIG. 4

FIG. 2—View westward across northern end of the Laguna Salada Basin. Note road and telegraph line connecting Mexicali and Ensenada passing down the smoother slope of the eroded fan. (Photograph by W. W. Weir.)

FIG. 3—Looking southward from the Mexicali-Ensenada road over the barren slope of the Sierra de los Cucupas, the eroded remnants of old alluvial fans, the vegetated piedmont alluvium, the smooth and barren area of Colorado River alluvium, the Laguna Salada. (Photograph by W. W. Weir.)

FIG. 4—Looking westward toward the base of the rugged Sierra de Juarez near its northern end.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—View southeasterly from camp at Pozo del Tule showing an "inlet" of the Colorado River alluvium and the encircling area of dune sand. Pickleweed in middle foreground; wingscale and mesquite on dunes in right distance.

FIG. 6—Crescentric dunes at base of Sierra de las Pintas. Plants are creosote bush and wingscale. (Photograph by J. S. Mejorada.)

FIG. 7—Looking southeasterly across the Colorado River alluvium toward the sand-mantled Sierra de las Pintas. (Photograph by J. S. Mejorada.)

water. Except for that fortunate circumstance, it would have been extremely difficult to secure much of the information regarding the basin floor, particularly its configuration.

Types of Land Surface

On the map, Plate V, four classes of land surface are recognized, exclusive of the bordering mountainous and rocky areas. They appear as irregularly sequential bands or areas with definite boundaries; in the field these areas are similarly distinct and definite, the chief exception to this being the boundary between the coarser deposits of the upper piedmont slopes and the finer materials on the lower slopes.

The most distinct and largest of these classes is the great central area of Colorado River alluvium. This extends from the southeastern end of the basin to within a few miles of its northern end, a distance of nearly fifty miles; nearly ten miles wide at either end, it is less than two miles wide at its central portion. This great body is practically free of vegetation, although along the *barranca* there is a narrow belt of pickleweed (*Salicornia ambigua*), arrowweed (*Pluchea sericea*), and cat-tail (*Typha angustifolia*). Along its western margin, from Pozo Cenizo northward, the wetter areas are marked by thickets of arrowweed and wingscale (*Atriplex canescens linearis*).

Around the margin of the valley floor are intermittent areas of sand dunes. These dunes are commonly ten feet or more in height; some in the southern part of the basin are extremely subject to wind action and have developed characteristic crescentic forms, although most of the dunes are capped with a mixed growth of wingscale, creosote bush (*Larrea divaricata*) and mesquite (*Prosopis juliflora*).

Above, and even between, these areas of sand dunes are the similarly intermittent areas of fine-textured piedmont materials. These have a gentle slope, with a fall of one to three per cent, marked by minor hummocks a few inches in height about the scattered clumps of vegetation. The characteristic vegetation of these areas is creosote bush, with a few wingscale, mesquite, and ironwood (*Olneya tesota*). As the upper limits of these areas are approached, the material becomes coarser, the gradient greater, and the creosote bush less dominant.

The upper piedmont slope comprises steeply sloping areas of coarse gravelly material and extends in an almost unbroken band along the base of the mountains. Near the canyon mouths, these areas are marked by the dividing and diminishing courses of ephemeral distributaries. These are stonier and coarser. They are characterized by a predominance of ironwood and paloverde trees, while the vegetation on the interfluvial areas includes ocotilla, cholla, and

numerous cactoid forms, in addition to the creosote bush, wingscale, galleta, and other plants of the lower slopes.

The rugged mountain masses are chiefly granitic in character, although extensive exposures of basaltic and other basic igneous rocks occur in the southern part of the region. In the vicinity of Sierra de las Pintas some sedimentary and metamorphosed rocks occur, while in the northern part a small butte at the base of the Sierra de Juarez was composed, in part, of limestone. Exfoliation and weathering has been active, and the torrential rains have cut deep canyons. Except for a few isolated group of native palms (*Washingtonia filifera*) situated in more favored spots, these barren slopes are marked only by an occasional, struggling cactus.

Trails and Water Supply

A few words regarding the condition of the water holes and trails may well be added for the guidance of the visitor unfamiliar with this desert basin. With the exception of the Mexicali-Ensenada road across the northern end of the basin, there are no regularly trav-

FIG. 8

FIG. 9

FIG. 10

FIG. 8—Shore line of the Laguna Salada at base of the Sierra de los Cucupas; note high-water marks on rocky wall at right.

FIG. 9—Looking southerly along the channel in the central part of the basin: trapped in this eight-mile channel the overflow water slowly evaporates. (Photograph by W. W. Weir.)

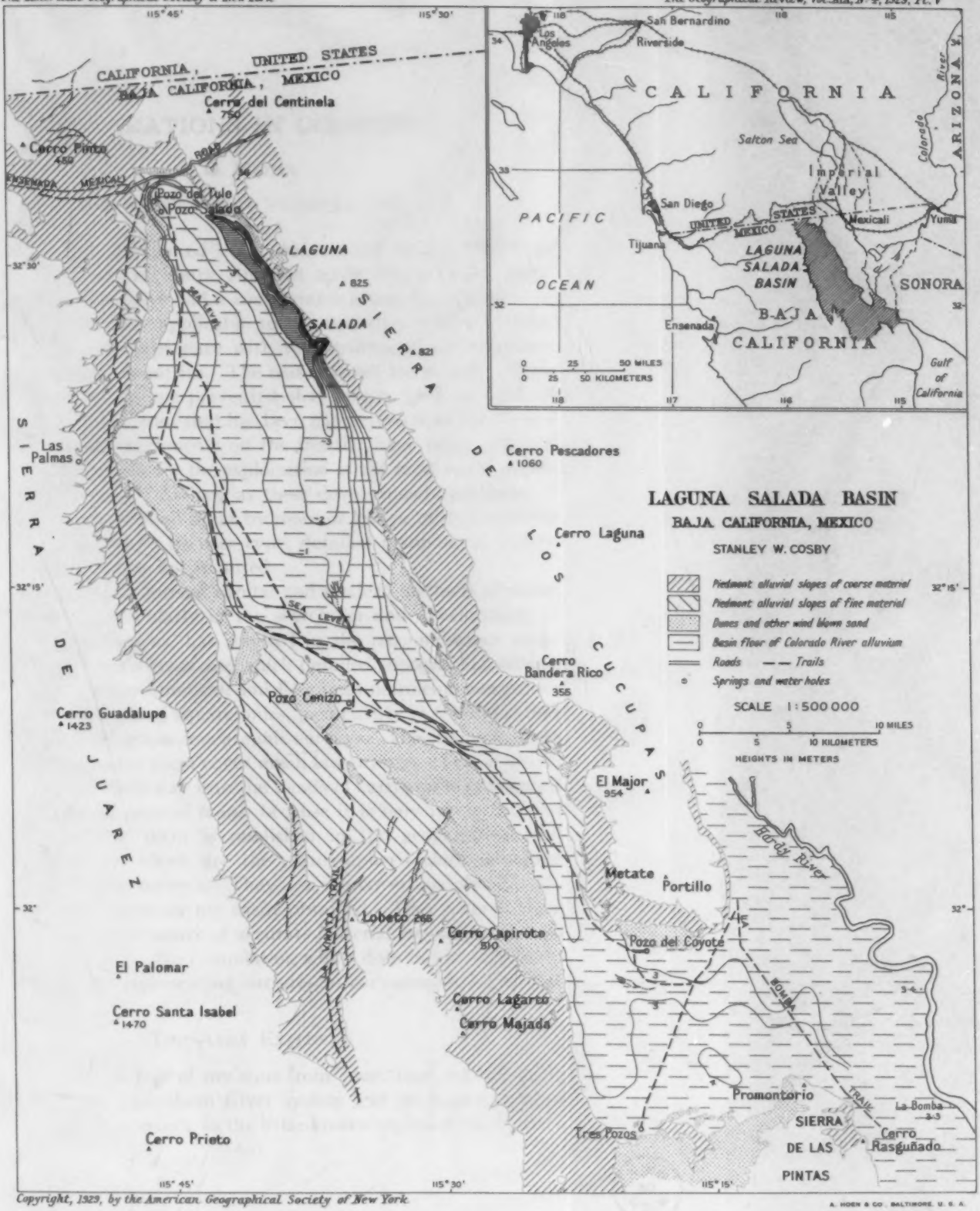
FIG. 10—Looking down upon one of the larger groups of native palms (*Washingtonia filifera*) at Las Palmas.

eled roads. Of the trails in the central part of the basin the easternmost was a temporary track made by a transient fisherman who netted mullet in the waters of the *barranca;* the middle one was a low-level trail followed by the truck that plied between the La Vinata distillery and Mexicali; and the westernmost, passing near Las Palmas, is simply the distinguishable portion of the high-level trail of this same truck. At the southeastern end of the basin is a short part of the La Bomba trail, connecting Mexicali with the tiny gulf port of that name. From the La Bomba trail to the Tres Pozos water hole is a route commonly followed by the cattle drivers from more southern localities on their way to Mexicali. This is connected with the La Vinata trail by a very poorly defined track that passes near Pozo Coyote and Pozo Cenizo.

Although, when dry, the smooth hard surface of the Colorado River alluvium makes an excellent roadbed, when wet either by flood waters or rains it is soft and impassable; at such times travel is confined to the surrounding piedmont slopes, and the lower trails are obliterated.

Except for the Pozo del Tule, in the northern part of the basin, and at Las Palmas, there are no dependable supplies of potable water in the basin. The water holes around the margin of the relatively impervious Colorado River alluvium are shallow pits excavated in localities of high water table. In contrast to the others, Pozo del Tule apparently has a never-failing supply of water, the water welling over the top of its wooden sides.[3] In case of dire necessity, the traveler possibly could secure a temporary supply of water by digging along the western margin of the valley floor where a fresh growth of arrowweed suggested the presence of a relatively high water table.

[3] At the time of these investigations a small trout-like fish (one to five centimeters in length) was darting about in the water of the Pozo del Tule. Although no specimens were collected, it is believed that these might be *Lucania brownii*, found by MacDougal in a warm spring on the opposite side of the basin in 1907 (D. T. MacDougal: The Desert Basins of the Colorado Delta, *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 705–729).



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EXPLORATIONS IN COLOMBIA

F. O. Martin

[With separate map, Pl. VI, facing p. 636]

"SETTLED but unexplored" is a phrase which in all of the West Coast republics of South America aptly characterizes many large areas that have had a considerable population for generations. It is particularly applicable to the countries north of Chile. Cartography has not kept pace with the settlement and economic development of these countries. The reason is not far to seek. Their physiographic make-up has prevented that steady pushing back of the frontier on a broad front that has been characteristic of the United States. Instead, encroachments on the frontier have taken place in widely scattered sections for the exploitation of the most easily developed natural resources. As long as these developments consisted of mining carried on in limited areas by more or less primitive methods and of agriculture of the frontier type, detailed mapping or in fact mapping of any sort was not required.

The introduction of foreign capital and modern methods of study and exploitation, particularly in the search for and development of petroleum-yielding regions, has resulted in the reconnaissance mapping of many extensive areas and much detailed topographic survey. In the last fifteen years American and European petroleum companies have covered thousands of square miles, particularly in Colombia and Venezuela, with high-grade topographic surveys. The reconnaissance surveys which preceded them cover much larger areas. Few of them, however, ever find their way into the hands of cartographers engaged in the production of general maps, because it is only rarely that information concerning them is published in the geographical and geological periodicals which are the cartographer's chief source of information as to new surveys. They are, moreover, mainly of confidential nature and therefore not easily obtained. They form at present the most important source of accurate material for compiled maps of these two countries. No compilation which does not include them can be considered as representing our present cartographic knowledge of these countries.

THE AREA EXPLORED

I spent about one-half of my time from June, 1920, to February, 1926, in the upper Guayabero River system and the upper parts of the Balsillas and Pato rivers, in the little-known region of the Eastern

Cordillera of the Andes and the western border of the llanos south of Bogotá. Since the objective was the mapping of lands owned by the Union Oil Company of California and the determination of their geological character, exploration was limited to the areas necessary for the carrying out of this purpose. The results are shown on the map, Plate VI, facing p. 636.[1] It is obvious that much exploration and mapping remain to be done before the topography of the region is completely known. Previous to my exploration, however, the region was practically unknown cartographically, and current maps show its topographic features so erroneously and so confuse the nomenclature of them that they are only a handicap to the explorer. Some notes on the topography accompany the map, and I shall precede them with a brief description of the region in general.

From the Magdalena to the Llanos

From the Magdalena to the llanos in the area covered by the map five climatic belts may be recognized running roughly parallel from north to south. On both sides of the Magdalena is a strip of more or less flat lands of varying width with a desert vegetation. The occasional rainfall that occurs there is torrential. This desert strip is narrower on the east side of the river than on the west. In fact, south of Natagaima and also near the mouth of the Rio Sumapaz the foothills of the Cordillera Oriental extend to the Magdalena.

As one goes eastward into the foothill region the vegetation gradually changes, and at 700 meters elevation the *templada*, or coffee country, as it is commonly called, is reached. The climate there is delightful as far as temperature is concerned, but the rainfall is heavy. The *templada* extends to an average elevation of about 2000 meters and in places still higher. Within this belt, above and below the junction of the Ampica and Cabrera rivers, is a typical desert region—its center being the village of Columbia—where it rarely rains and where the temperature is warm, though not excessively so, throughout the year. The "cold country" begins on the west side of the cordillera at about 2000 meters, although in the narrow river valleys of the interior of the cordillera its lower limit extends to 1700 meters. There is no plateau region south of the Sabana de Bogotá and no *páramo* region south of the Sumapaz mountain complex.

On the east side of the cordillera the cold zone is much narrower than on the west side, particularly south of the Sumapaz complex, and the *templada* is correspondingly wider and extends down to 500 meters above sea level. North of the Río Guejar and extending north-

[1] Credit is due the Union Oil Company of California, which paid for all of this work, for permission to publish the geographical results. The company has also contributed the original surveys on which the map which accompanies this article is based for compilation into the Bogotá and Cali sheets of the American Geographical Society's Millionth Map of Hispanic America.

easterly into Venezuela the llanos stretch away for hundreds of miles unbroken by any tree growth except moriche palms near lagoons and gallery forests bordering the creek and river courses. South of the Río Guejar and the lower Río Ariari to its mouth in the Guayabero is a sandstone plateau which reaches to elevations of 1500 meters and is practically unexplored. Along my route I found it covered with virgin forest. Farther south, however, on the Mesa de Yari and probably also on the Mesa de Pardaos, llanos conditions again exist according to what I believe to be reliable information.

Settlements in the Cordillera Oriental and in the Llanos

There is a considerable population between Chipaque and Quetame along the Bogotá-Villavicencio road. Cáqueza, the largest town, with a population which I estimate at somewhat over 8000, is picturesquely situated high above the right bank of the Río Cáqueza. The inhabitants of the district are chiefly of mixed white and Indian blood. They are distinctly mountain types, short and stockily built and of great endurance. From Quetame on toward the llanos one encounters mainly isolated houses, although in places as many as a dozen may be found grouped together. Villavicencio, the capital of the Intendencia del Meta, is a growing town with an estimated population of 6000 to 8000. It stands on the western border of the llanos, and here one notices a change in the appearance of the people. Although there is still a considerable element of the mountain type, the majority of the inhabitants are whiter, taller, and more slender. These characteristics increase as one advances farther into the llanos, and the mountain types gradually disappear.

Of the llanos very little is known even by Colombians. Much less is known of them now, in fact, than at the end of the Spanish régime. Certainly they had then a much larger white and mixed population than now and furnished pastureland for thousands of head of cattle. During the War of Independence and the long succession of civil wars that followed the establishment of the republic the herds were broken up and the ranches and settlements largely deserted. The picturesque llanero, the Colombian counterpart of the gaucho of the Argentine Republic and Uruguay, has completely disappeared. Whole villages of the colonial period seem to have vanished. For instance, three maps executed by Francisco Requena in connection with the dispute between Spain and Portugal over the extent of their respective territorial rights in South America and dated September 1, 1779, April 1, 1783, and July 1, 1788, all show the village of San Juan de los Llanos, which I assume was located where the village of San Juan de Arama was later founded between the Acacias and Malpaso quebradas. I have seen in the village of Mesetas, a short distance west

FIG. 1

FIG. 2

FIG. 1—Cáqueza (altitude 5150 feet), the chief town of the *templada* zone east of Bogotá. View looking northwest.
FIG. 2—The plaza of Quetame, another town of the *templada* zone.

FIG. 2—The plaza of Quetame, another town of the *templada* zone.

FIG. 3

FIG. 4

FIG. 3—Scene on a cattle ranch on the llanos near San Martín.
FIG. 4—The Río Guayariba between Villavicencio and San Martín.

of this location, an old church bell bearing inscriptions up to the eighteenth century that had come from San Juan de Arama. The spot where this village stood is now covered by the jungle.

The only settlements of any consequence south of the Bogotá-Villavicencio road are San Martín and Uribe. San Martín has a notoriously and deservedly bad reputation on account of its high rate of mortality.[2] When I last passed through the town in August, 1924, a so-called *pesta*, epidemic, was at its height.

Uribe, near the upper Río Duda on the Columbia-Uribe-San Martín trail, consists of the usual plaza with two short streets leading off from each corner. There are in all perhaps forty houses, a church, a school, and a jail. This village has a history somewhat typical of the changes and vicissitudes that characterize the majority of the settlements of the eastern flanks of the Andes and the llanos border. It was established in the eighteen-seventies, when the trail from Columbia to the Llanos de San Juan was built, and was named after Francisco Antonio Uribe, an energetic native of Antioquia who was the first Colombian really to attempt on any large scale the development of the immense resources of the region. He and his associates were first engaged in the quinine bark industry. At times they employed thousands of laborers and at first acquired lands on the west side of the Cordillera Oriental for the breeding of pack mules for transporting cargoes across the cordillera and of cattle to feed their employees. It was found that the west side properties were insufficient to supply the demand. Properties were therefore acquired in the llanos, and a road was opened across the main range of the cordillera at its lowest point, the Paso de las Cruces. To provide halting places and pasture for the cattle on their way from the plains, more lands were acquired on the Tigre, Papamene, and Duda rivers, and the settlement of Uribe was founded. After the fall in the price of quinine in 1887, Uribe and his associates turned to the extraction of rubber and the raising of cattle for the market. These two enterprises were apparently very profitable for some years; but the civil war of 1899–1902 made it impossible to supervise the work. Nearly all of the cattle were stolen, and the rubber collectors were all engaged in fighting. It is reported that before the revolution there were 14,000 head of cattle in the Llanos de San Juan.

After the civil war rubber collection was resumed and continued until 1912, when the price of rubber dropped to a point where it was no longer profitable. Some quinine plantations were established near the western side of the Paso de las Cruces, and rubber trees were planted near some of the affluents of the Río Duda; but they were abandoned because of lack of cheap labor—in fact, of any labor at all. While the

[2] Compare Hamilton Rice: Further Explorations in the North-West Amazon Basin, *Geogr. Journ.*, Vol. 44, 1914, pp. 137–168.

quinine and rubber exploitation was going on much land was cleared for the growing of agricultural products for food for the laborers. Coffee and cacao plantations were also established. Many of the inhabitants left when the quinine and rubber markets failed. Those that remained gradually spread out along the Río Duda and its affluents and made a number of clearings where plantains, cacao, coffee, maize, yuca, and tobacco are grown. Their only exports now are small quantities of cigars and cacao and a few pigs and cattle. All agricultural products adapted to the region grow in great abundance, and the inhabitants could live a very contented life if it were not for their trading and hunting propensities. Instead of attending to the work on their clearings the men will waste days to make some sort of trade and will travel long distances over wretched trails to take a few dollars worth of cigars or a pig or cow to the market at Columbia or San Martín.

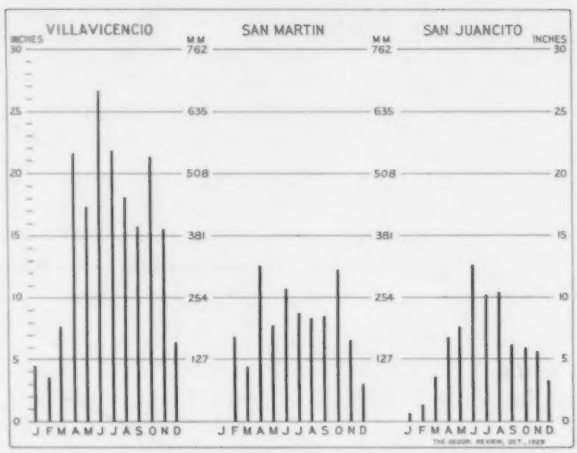


FIG. 5—Graph of monthly rainfall (average for 1925 and 1926) at stations in the Intendencia del Meta, drawn from data furnished by Dr. Sarasola, Chief of the National Observatory at Bogotá.

Whereas on the west side of the Cordillera Oriental there are two dry and two wet seasons, fairly well defined, on the east side there is only one wet and one dry season, the latter beginning in December or January. The rains, however, usually abate somewhat in August, and a so-called *veranciito* (little summer) lasts for about thirty days.

From Puerto Crevaux down the Río Guayabero and from La Julia down the Río Duda there are no settlements, and not even isolated houses are encountered until one reaches the junction of Río Ariari and the Río Guayabero. There are very few Indians in that part of the llanos covered by our surveys—none at all in the villages mentioned above. Each year some twenty men, women, and children of the Guahibo tribe from near the lower Ariari visit the settlements on the Llanos de San Martín. They do not come to work but camp beside the streams, do some fishing, make pottery, and trade a few hammocks for cotton cloth and trifles of various sorts.

The whole region of the eastern border of the Andes and the llanos offers unusual opportunities for agricultural development as far as soil and climate are concerned. Coffee can be grown profitably. Cacao is a less certain venture on account of diseases which affect

the trees. The llanos are admirably suited to cattle raising on a large scale. Grass grows nearly everywhere to knee height, and there is an abundance of running water and many lakes and ponds, while the strips of forest that line all the streams furnish shade.

Three chief drawbacks to the settlement and development of the region are the lack of kept-up roads and trails and the lack of a good labor force. There is no community spirit among the inhabitants in the matter of maintaining trails or in any other communal relations. Coöperation is unknown; rather, intense jealousy among individuals prevails. Very few trails are laid out according to the approved practice of following the contours in gentle gradients. Most of the trails go straight up the mountains and steeply down the other side. Horses are practically useless on these trails, and even mules cannot stand continuous travel on them for more than a week at a time. In the rainy season better time is made on foot. Even the so-called *camino nacional* between the town of Columbia and the Llanos de San Juan is at best only a miserable trail.

The present inhabitants from which the labor supply must be drawn are shiftless and rarely stay in one place long enough to establish a home. They cannot be depended upon to work steadily. Very few can be secured to work for more than a week at a stretch. The result is that the only paying industry of any proportions since rubber exploitation ceased is cattle raising, which requires little labor in proportion to the capital invested.

Topographic Notes: The Cordillera Oriental

The Cordillera Oriental south of Bogotá is one of the least-known parts of the whole Andean chain. This section has none of the high savanas with their rich soil and dense population which characterize the cordillera from Bogotá northward. It has not been to any extent explored for mineral resources nor has it heretofore been the subject of physiographical or geological studies except for the work of Hettner,[3] who in 1882 carried his investigations as far south as the latitude of the Río Fusagasugá.

The valley of the Magdalena there narrows, and the crest of the cordillera which forms the main divide between the Magdalena and the Orinoco system approaches much closer to it than farther north. Southward from the Páramo de Sumapaz this crest lowers rapidly until at the Paso de las Cruces at the headwaters of the Papamene branch of the Río Guayabero its elevation is only 6147 feet—the lowest pass in the Cordillera Oriental south of Bogotá and, I believe, considerably lower than any pass farther north. The lowest pass in the

[3] Alfred Hettner: Kartographische Ergebnisse einer Reise in den Columbianischen Anden, *Petermanns Mitt.*, Vol. 34, 1888, pp. 104–112; *idem:* Die Kordillere von Bogotá, *Ergänzungsheft No. 104 zu Petermanns Mitt.*, 1892.

FIG. 6

FIG. 7

FIG. 6—Desert vegetation in a dry pocket of the Río Cabrera valley, on the western side of the Cordillera Oriental.

FIG. 7—The Río Papamene, tributary of the Guayabero, seen from the northwest.

vicinity of Bogotá is 9932 feet according to our measurement, and the Paso de Santa Lucia at the headwaters of the Río Fortecillas is 8302 feet. The pass between Andalucia and Florencia, near the Río Caquetá, is reported as 7872 feet.

Hettner[4] has called attention to the fact that most of the rivers of the Cordillera Oriental flow at first in longitudinal valleys with a general north or south direction parallel to the main ridge of the

FIG. 8—The plaza of Villavicencio, capital of the Intendencia del Meta.

cordillera. His explorations, however, did not extend south of the Río Fusagasugá. We found his observations to be true on the west side of the cordillera north of the Río Cabrera. Farther south, however, most of the rivers flow in transversal valleys except for short distances from their sources. On the eastern side of the cordillera the Río Negro (as the upper course of the Río Guayariba is called) flows in a longitudinal valley until it breaks through to the llanos; but the Ariari, Guape, and Guejar flow for the greater part of their courses in transversal valleys. The Tigre and the Papamene flow southward in longitudinal valleys, as does also the Guayabero from Puerto Crevaux to a point near the mouth of the Duda. The Duda flows south-southeast in a transversal valley.

THE LLANOS

The Llanos de San Juan, formerly called the Llanos de San Juan de Arama, lie between the Río Guejar and the Río Ariari. They are distinguished from the Llanos de San Martín, which lie farther north between the Río Ariari and the Río Humadea, by their greater eleva-

[4] Hettner: Die Kordillere von Bogotá, p. 41.

tion—they average 300 feet higher—and their more luxuriant vegetation. The grasses grow better there than in the Llanos de San Martín and are said to furnish better pasture for cattle; and the gallery forests which line the quebradas and *caños* are thicker and wider. Two table mountains, the Mesa de Yamen, which lies somewhat isolated between the flood plains of the Ariari and the Guape, and the Mesa de Fernando between the Guejar and the Guape, form the western border of the

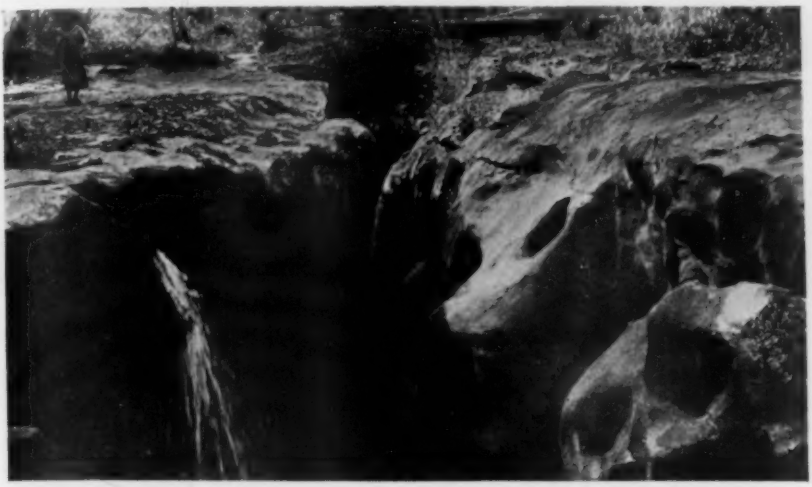


FIG. 9—Caño of the Quebrada Las Penas, a stream cutting through the sandstone Cordillera de Macarena.

Llanos de San Juan. It was probably these that Dr. Rice identified as the Cordillera de Macarena.[5]

THE SANDSTONE CORDILLERA DE MACARENA

The Cordillera de Macarena is in fact an extensive sandstone plateau. The Río Guejar, after leaving the cordillera proper, flows along its northern edge. The Guayabero enters it below the mouth of the Río Duda. Dr. Crevaux[6] gives graphic descriptions of two *angosturas*, or rapids, on the Guayabero in its passage through this cordillera before it reaches the Ariari. He describes the first as varying in width from 39 to 82 feet and as being 1⅕ miles long with walls 150 feet high. It is apparent that the cordillera extends across the Río Guayabero to the south. Its southerly extension is very likely represented by the Sierra Chiribiquete shown on Dr. Rice's map. Dr. von Bauer[7] calls the dissected plateau country between the Sierra

[5] *Op. cit.*, p. 143 and map.

[6] Jules Crevaux: Voyages dans l'Amérique du Sud, Paris, 1883.

[7] Peter-Paul von Bauer: NW-Amazonien: Ein Beitrag zur Geographie Aequatorial-Amerikas, Inaug. Diss., Brünn, 1919.

Chiribiquete and the Cordillera de Macarena the Mesa de Pardoas, and, from his description of the latter, I believe it to be identical in character with the Cordillera de Macarena.

The Cordillera de Macarena has never been crossed between the Río Guayabero and the north of the Río Duda on the south or between the Río Guejar and the Río Ariari on the north. Even the rubber gatherers, formerly rather numerous in this territory, failed to cross it, although an expedition tried it once in search for a shorter route between the Llano de San Juan and the Río Guayabero. I twice attempted a crossing from the Río Duda above La Julia, as the map shows, but was turned back not only by the impassable chasms but also by the failure of provisions both at the point and at the base on the Río Duda. From what I have seen at a distance from the northeast, north, and west, I believe the whole region to be a sandstone plateau weathered into the present fantastic forms which led the early Spanish and German explorers to imagine that they were the spires and turrets of old cities—the ever-searched-for El Dorado with its golden treasures.

The top formation is of massive, cleft, whitish-yellow quartzose sandstone over 600 feet thick. This sandstone has become very porous through the washing away of its cementing materials by the heavy rainfall of the region. The isolated peaks, towers, and columns are due to the difference in the size of the sandstone particles and the amounts of cementing materials. Throughout the entire formation is a system of joints and fissures perpendicular to the sediments and crossing each other at right angles. The fissures, which have the same easterly slope as the formation itself, are particularly well-defined and in places have been eroded six feet wide and 200 feet deep. The steep sides of the plateau usually have a dark, shiny, hard surface, which gives the rocks an appearance of volcanic origin that is not disproved until the surface is chipped off. This protective crust, called tropical gloss, is the same as the desert varnish of the North American deserts and is produced by the mineral solutions within the rock coming to the surface through capillary action and the through-heating of the upper rock layers.

The fact that the Caño Grande branch of the Río Inirida and the Río Uaupés have their sources to the east end of the Mesa de Pardoas and that the Guayabero seems to be the only river large enough to have broken through the Cordillera de Macarena, leads me to believe that the Balsillas and Pato rivers are not affluents of the Río Guayabero but have been forced by the Cordillera de Macarena or its southern extension into a southerly course and are, therefore, a part of the Caguan-Caquetá-Yari-Caquetá system; that is, they pertain to the Amazon drainage. This opinion is strengthened by various reports, among which is a report made to the Colombian

government by the Comisario de Caquetá, May 31, 1925, in which it is stated that the Río Caguan is identical with the river called Balsillas at its source and that the Río Pato is the source of the Río Yari.

In the bed of the Río Guejar west of the Llanos de San Juan, the flat-lying formations of the Cordillera de Macarena lie unconformably over banks of hard shale, quartzite, and arkose, which dip 80° south and 55° east; its outcrops having been truncated almost level as far as they could be seen from near the river banks. The difficulty of doing geological work in this tropical region is illustrated by the fact that I had been near this place four times in different years and did not discover this unconformity till 1926 when the river was very low. At other times the underlying formations were deep under water and on the shores covered by gravel banks and detritus. It is apparent that the extensive sandstone plateau from the Río Guejar southward is distinct from the formations and structure of the Cordillera Oriental. Studies of this feature are still under way.

As Bauer has indicated, the surface of the plateau becomes more uniform the farther one travels west from the headwaters of the Caño Grande and the Unilla and Itella rivers. I have had similar information. Moreover, the plateau some distance east of the Río Caguan is called the Llanos de Yari; and the fact that within the last few years a cattle industry has been developed in these llanos would indicate that they cannot be so broken and covered by dense forest vegetation as are the Cordillera de Macarena, the Mesa de Pardoas, and the Sierra Chiribiquete.

Principal Rivers: Affluents of the Río Meta

My expedition crossed all of the left bank tributaries of the Río Meta down to the point where the main stream is known as the Meta. We found the nomenclature of these streams as they appear in previous maps and descriptions very misleading. The name of even the main stream varies from place to place; and the Río Humadea, which is given by most cartographers and writers as the principal headwater affluent of the Meta, was found to carry much less water than the Guayariba. The name of the latter changes to Río Negro above the bridge on the trail from Villavicencio to San Martín, as shown on the map; while the name Río Negro is also given to a stream which has its source 3½ kilometers east of the bridge and is called Candelaria for a short distance from its source. During a part of the rainy season part of the water from the Río Guayariba flows into the Candelaria, and the latter is called the Río Negro downstream from the point where it receives this overflow. Stübel[8] describes the Río Negro as

[8] Wilhelm Reiss and Alfons Stuebel: Reisen in Süd-Amerika: Geologische Studien in der Republik Colombia (3 vols., Berlin, 1892–1899), Vol. 3, p. 119.

emptying into the Río Guataquia. The Guataquia, however, unites with the Río Umea about ten miles west of the mouth of the Río Negro in the Río Umea, and the latter continues as the Umea to the point where it joins with the Río Humadea to form the Río Meta. It would be well if the names Guayariba and Río Negro (as applied to the Upper Guayariba) could both be abolished and the name Meta applied to the whole stream from its source.

Affluents of the Río Ariari

The rivers shown on our map as entering the Río Ariari from the north before the latter reaches the llanos were taken from information given by Ricardo Lleras Codazzi[9] and also from surveys made by Colombian engineers some fifty years ago of land now owned by the Union Oil Company. From experience in checking other surveys derived from similar sources, I am sure that these surveys are only approximate. The Río Iraca enters the flood plain of the Río Ariari at El Porvenir and probably flows nearly parallel to the Ariari for some miles before joining it. Eastward from San Martín I explored the water divide between the Ariari and the Meta and believe that I reached the sources (not mapped) of the Caño San Vicente of the Ariari drainage basin and of the Río Manacacias of the Meta basin. It is reported that the portage between these two streams is only six miles.

Our examination of the southern affluents of the Ariari was much more thorough and proved the complete inaccuracy of the official Colombian maps. The principal southern tributary is the Río Guape, which unites with the Ariari at the point where the latter is crossed by the trail from San Martín to the Llanos de San Juan. I was informed that up to 1917 the mouth of the Guape was some five miles farther upstream. At present it enters a broad flood plain about 16 miles from its mouth and divides into numerous branches, all of which finally reach the Ariari.

The next largest southern tributary of the Ariari is the Río Guejar, which has its source in the Páramo de Sumapaz. It flows first in a southerly direction as far as the village of Mesetas, where it is turned eastward by the Cordillera de Macarena. Thence it flows for some distance along the northern end of the cordillera and, then entering it, flows between banks several hundred feet high, first easterly, then southerly, and finally southeasterly. At Mesetas the river is 160 feet wide and can usually be forded diagonally by sending men into it to find the shallowest places. In the llanos between the Ariari and Guejar are a number of quebradas which contain considerable water and can

[9] Ricardo Lleras Codazzi: Reseña Geológica del departamento de Cundinamarca, Cordillera Oriental de los Andes Colombianos, *Proc. Second Pan Amer. Sci. Congr., Washington, U. S. A., December 27, 1915, to Jan. 8, 1916*, Vol. 8, Section 7, pp. 351–362; and Notas mineralogicas y petrográficas, Museo Nacional, Bogotá, 1925.

be navigated in *canoas* for some miles from their mouths. Of these quebradas, Acacias and Honda flow into the Río Guejar, and the Cunimia into the Río Ariari. The divide between the Ariari and the Guejar was not examined but is doubtless the series of low hills, *serranías*, which we observed from a distance. The Guejar is essentially a mountain stream with a considerable fall and is eroding vertically, while the llano streams such as the Acacias, Honda, and Cunimia have little fall and are eroding laterally.

Drainage System of the Río Guayabero

We ascended and mapped a section of the Río Guayabero to a point somewhat less than three miles from Puerto Crevaux, the name given to the place where Crevaux on October 25, 1861, started on his remarkable trip down the river to its mouth in the Orinoco. Only cinchona bark gatherers have ever reached the sources of the Río Guayabero, and, since no cinchona bark has been gathered for more than forty years, I found only one man who had been over the route. Our surveys, however, prove that on all published maps the plotting of the upper river is completely wrong. No stream of any size can enter the Guayabero from the south above Puerto Crevaux. I observed a high range of mountains, an outspur from the Cordillera Oriental, from both the north and south. The source of the Guayabero must be about east of Barraya, since in years gone by there was a trail between Uribe and Barraya. It is probable that the headwaters of the Guayabero, Balsillas, Venado, and Guaraco, flowing respectively to the northeast, southeast, northwest, and southwest, are all close together under conditions such as exist on the Páramo de Sumapaz where the Ariari and Guejar flow northeast and southeast respectively and the Sumapaz and Cabrera northwest and southwest.

Between Puerto Crevaux and the first *salto* downstream, where the river cuts through the Cordillera de Macarena, several small streams enter the Guayabero from the south side. One of these, which joins the main stream a few miles below Piedra Julio, the end of our survey, is said to be the Río Caraguaja. One of our engineers, Curt Zeiz, made an exploration of the upper part of the Río Pato and of Piedra Julio. He was drowned, however, or murdered by his native helpers, in November, 1923, after reaching the Río Guayabero. His notes were recovered, and his route mapped from them shows that the country he traversed was extremely rugged with streams flowing in deep canyons. I have refrained from connecting the creeks traversed by his route, but I believe that they belong to the Río Caraguaja drainage. It must be stated, however, that here and everywhere throughout this region the names of rivers repeat themselves and that

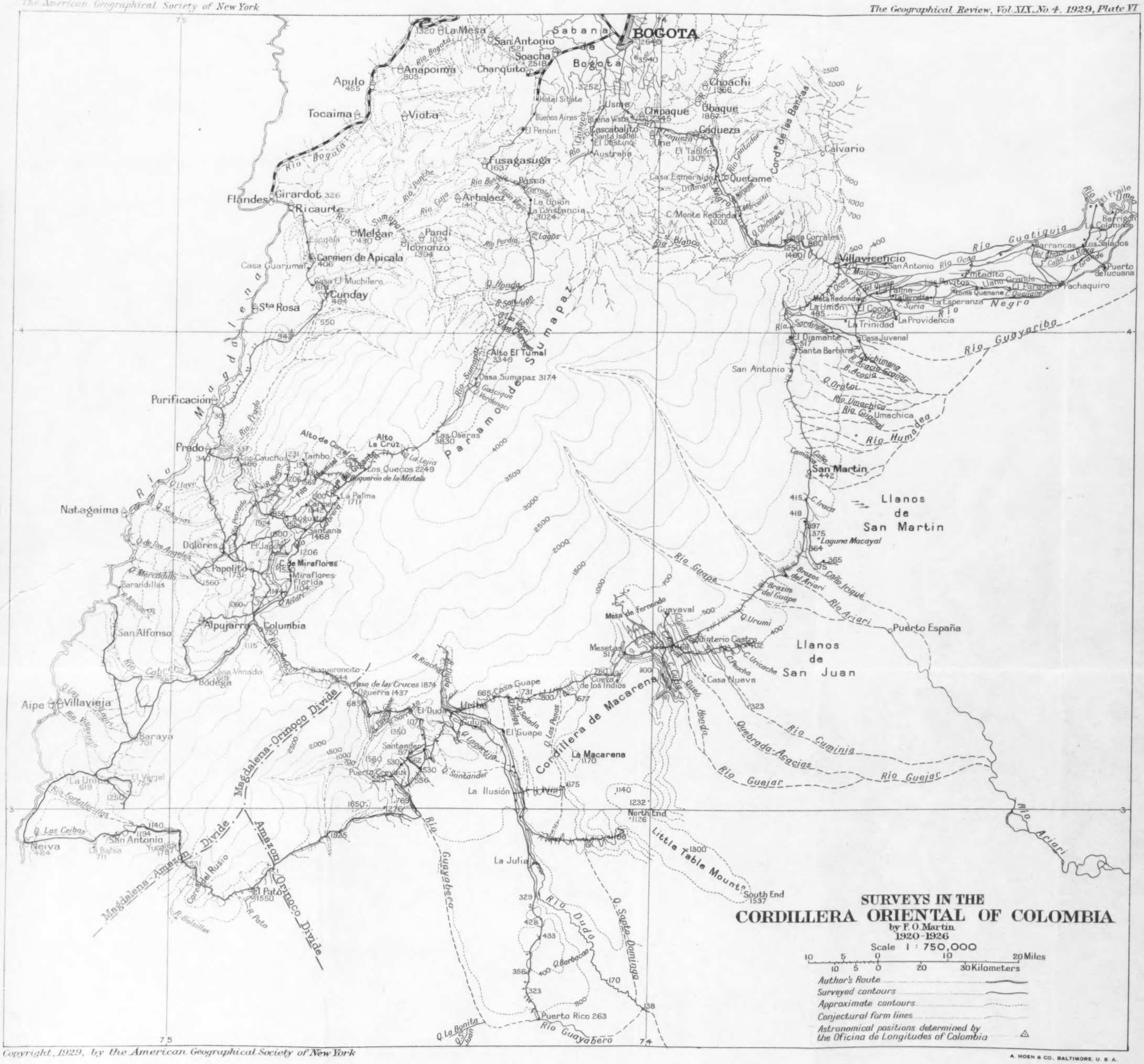
another Caraguaja is said to exist which unites somewhere with the Río Pato of the Caquetá system.

The first large river entering the Río Guayabero from the north is the Papamene, which we explored from its mouth to the point where it is crossed by the Columbia-Uribe trail, although the lower part was not actually surveyed. It has a larger drainage area and carries a much greater volume of water than the Guayabero above their junction. It is 135 feet wide where the trail crosses it and can only be forded on muleback during the end of the dry season in February or March. The principal channel of the Río Guayabero at Puerto Crevaux is 270 feet wide, and I could cross it but once on muleback and then only with the help of a native leading the animal by a long rope.

Below Puerto Crevaux, on the left bank, the quebradas Tigre and Reserva and the Río Duda join the Guayabero. Zeiz and I explored the latter all the way from Uribe to its mouth. From La Julia downstream the exploration was made in a *canoa;* but, by checking the velocity of the *canoa* a number of times along measured distances and by repeating the survey upstream, I believe we obtained a fairly accurate survey. For some distance upstream from its mouth the Río Duda has the appearance of a large lake with almost no current, while the Río Guayabero is still a great mountain torrent with much vertical erosion.

Methods of Survey

For the surveys from which the accompanying map has been compiled the Brunton compass was chiefly used. The Zeiss stereotelemeter was used occasionally, and it would be an ideal instrument for both land and river reconnaissance work if it did not get out of adjustment so easily. In fact, I have found it impossible in these regions to keep any delicate instrument in adjustment for any length of time. It is impossible to make the native boatmen or carriers understand that even a slight knock makes the instrument useless. Heights along the route of the survey are from aneroid readings checked by boiling-point thermometers with a von Dankelmann hypsometer made by Fuess of Berlin. The thermometers used had all been examined and certified by the Physikalische Technische Reichsanstalt of Berlin. I cannot explain the rather large differences between the elevations determined by Dr. Rice and by my expeditions at Cáqueza, Villavicencio, and San Martín, as they were doubtless made in the same places, at or near the plazas in these villages. The Oficina de Longitudes of the Colombia government gives altitudes between Dr. Rice's and mine as follows, calculated in feet:


BOGOTA
Sabana de Bogotá
La Mesa
San Antonio
Soacha
Anapoima
Charquito
Apulo
Tocaima
Viotá
Choachi
Usme
Chipaque
Ubaque
Cáqueza
Cascabalito
Fusagasuga
Pasca
Arbaláez
Flándes
Girardot
Ricaurte
Melgar
Pandi
Icononzo
Carmen de Apicala
Cunday
Sta Rosa
Casa Guarumal
Casa El Muchilero
Escuela
Purificación
Prado
Natagaima
Dolores
Papelito
Baraya
Aipe
Villavieja
Neiva
San Alfonso
Alpujarra
Columbia
Miraflores
Florida
Bodega
Casa Venado
Alto El Tumal
Casa Sumapaz 3174
Las Oseras
Alto La Cruz
Los Quecos 2249
Boquerón de la Mistela
Tambo
Los Caucheros
Augustinos
Santana
El Japón
La Palma
Alto de Correl Colorado
Paso de las Cruces 1874
Oquerra 1437
Boqueroncito
Puerto Coeyaux
Santander
Uribe
El Dudo
Cutupal
El Guape
Casa Guape
Cueva de los Indios
La Macarena
La Ilusión
La Julia
North End
South End
Puerto Rico 263
Quetame
Casa Esmeralda
Diamante
Negro
Monte Redondo
Casa Corrales
Calvario
Villavicencio
San Antonio
Pintadito
Barrancas
Los Salados
Puerto de Lucuana
Pachaquiro
El Paradero
Llano Grande
Los Pavitos
Toma Quenane
La Esperanza
La Providencia
La Trinidad
Casa Juvenal
El Diamante
Santa Barbara
San Antonio
Umachica
San Martin
Llanos de San Martin
Laguna Macayal
Mesetas
Guayaval
Mesa de Fernando
Quiterio Castro
Casa Nueva
Puerto España
Llanos de San Juan
Cordillera Oriental
Magdalena-Orinoco Divide
Amazon-Orinoco Divide
Magdalena-Amazon Divide
Cordillera de Macarena
Río Guayabero
Río Guape
Río Ariari
Río Guejar
Río Cuminia
Quebrada-Acacias
Río Humadea
Río Guayariba
Little Table Mountain
Río Duda
Q. Santo Domingo
Río Aciari
Río Bogotá
Río Sumapaz
Río Prado
Río Cabrera
Río Fortalecillas
Río Villavieja
Río Suaza
Río Patá
Río Balsillas
Río Ocoa
Río Guatiquia
Río Negro
Río Blanco
Río Chisacá
Río Cantalade
Río Perdio
Río Cuja
Río Pantano
Río Frailejones
Río Umea
Río Barriga
Río Colorado
Río Chichimena
Río Acacia Grande
Río Acacia
Río Guayabero
Río Duda
Río Guape
Río Ariari
Río Guejar
Río Cuminia
Río Aciari
Q. Honda
Q. Chiguira
Q. Ortotoi
Q. Umachica
Q. Guayaral
Q. Urumi
Q. Barbacoas
Q. La Bonita
Q. Santo Domingo
Q. Las Ceibas
Q. Las Peñas
Q. Salada
Q. Santander
Q. Mercadillo
Q. Llavi
Q. Señoras
Q. de los Angeles
Q. Ariari
Q. Lejia
Q. Verdenaci
Q. Guacirque
Q. Las Vegas
Q. Los Cerezos
Q. Lagarejo
Q. Las Peñas
Q. Cuja
Q. Honda
Q. Barbacoas
Q. Santo Domingo
Q. La Bonita
Q. Suria
Q. Cocuy
Q. Quenane
Q. Inacia
Q. Urumi
Q. Caño Icique
Q. Caño Camoruco
Q. Caño Iguaro
Q. Caño Iguaro
Q. Caño Iguaro

	Oficina de Longitudes	Rice	Martin
Bogotá	8659	8674	8659
Caqueza	5582	6212	5008
Villavicencio	1588	1832	1499
San Martín	....	1682	1409

During our explorations astronomical observations for latitude and longitude were made at several points; but most of the records were lost in crossing rivers, and only the latitude of El Duda, near the village of Uribe (3° 17′ N.), and the magnetic declination at the point (2° 25′ C.) can be accepted as correct. Observations for longitude by the Oficina de Longitudes place the longitude of Villavicencio 49′ 23.55″ east of the position given by Dr. Rice. On the map of Colombia on the scale of 1:1,000,000 published in 1920 by the Colombia government on the basis of astronomical positions established by the Oficina de Longitudes, Villavicencio has been placed at the position determined by the Oficina de Longitudes; but San José, Calamar, and other points farther south and southwest have been left as determined by Dr. Rice, because the Oficina de Longitudes has no determination for these points. My own work leads me to conclude that San José and Calamar should be shifted about the same distance west as Villavicencio.[10]

[10] In compiling the accompanying map Mr. Martin's surveys have been adjusted to astronomical positions determined by the Oficina de Longitudes as far as these were available. In order to give a picture of the region of Mr. Martin's surveys the courses of the right-bank tributaries of the Magdalena taken from various official Colombian maps as indicated in the list of sources given on the map have been adjusted to Mr. Martin's surveys at their headwaters and drawn in broken lines. Similarly east of the region of Mr. Martin's surveys the courses of the main streams have been plotted from Dr. Rice's surveys and from official Colombian maps, Dr. Rice's positions having been shifted westward as suggested by Mr. Martin. Approximate contours have also been sketched in broken lines outside the areas covered by Mr. Martin's surveys.—Edit. Note.

EROSION PAVEMENT

Charles F. Shaw

University of California

"EROSION pavement" is a surface covering of stone, gravel, or coarse soil particles accumulated as the residue left after sheet or rill erosion has removed the finer soil. It is in evidence whenever the soil mass contains fragments or cemented aggregates too large to be moved by the flowing sheet of water. These coarse particles check the flow of run-off of the surface water and thus reduce its powers of erosion. If, however, the surface flow is concentrated or increased to the point where the coarse particles can be transported, they act as additional cutting tools; erosive action increases; and deep, steep-sided gullies are excavated.

This action is clearly seen in Figures 1 and 2, showing erosion near Santa Monica, Cal. The soil here is Pleasanton loam,[1] containing a moderate quantity of gravel in the surface or A horizon but not enough to be classed as a gravelly loam. The subsoils, or B horizons, contain considerable gravel and are enriched with sufficient illuviated clay to be classed as clay loams. Cuts made by street grading afforded major drainage ways, and the burning of grass and weeds exposed the surface to washing by the winter rains.

Sheet erosion completely denuded the burned portion of its surface soil, but the sparse cover of unburned grass in the central part protected the surface and so reduced the erosion that three or four inches of surface soil still remain in place. The gravel that was present in the soil accumulated on the exposed subsoil to form an almost complete cover (Fig. 2) which served to protect the soil mass from further stripping. Where the volume of water was sufficient to move the gravels, however, deep gullies were cut, the gravels serving as efficient cutting tools.

The accumulation of gravel or stone as a protective covering is also shown in Figure 3, a cornfield on Dekalb stony loam in Clearfield County, Pennsylvania.[2] This is a primary or residual soil formed through the weathering of sandy shales, with many angular rock fragments throughout the soil mass. Sheet erosion has removed the fine material from a sufficient depth to give an "erosion pavement"

[1] J. W. Nelson and Others: Soil Survey of the Los Angeles Area, California, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1916* [*18th Rept.*], pp. 2347–2420.

[2] C. F. Shaw, W. C. Byers, and W. G. Ross: Reconnoissance Soil Survey of South-Central Pennsylvania, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1910* [*12th Rept.*], pp. 193–265.

FIG. 1

FIG. 2

FIG. 3

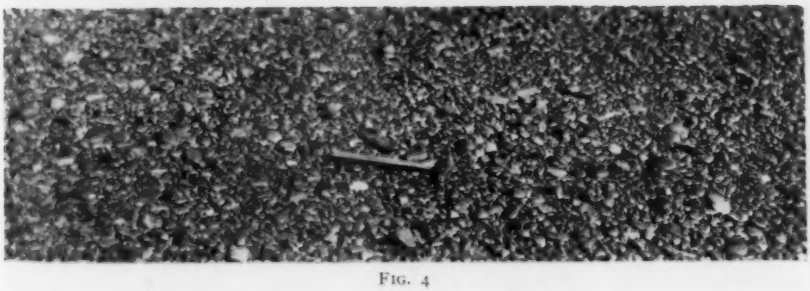


FIG. 4

FIGS. 1 and 2—Erosion near Santa Monica, Cal. The surface soil has been removed, and where the flow of water was concentrated deep cuts have been formed. The subsoils are protected by accumulation of gravels as an erosion pavement.

FIG. 3—An erosion pavement of accumulated stone fragments protects the surface and reduces further erosion. Dekalb stony loam. Clearfield County, Penn.

FIG. 4—Desert pavement on Palo Verde Mesa, Cal. The gravel content of the original material acts as a protective surface cover.

that completely covers the surface. The stone fragments are so large that they cannot be transported by the run-off water, and no gullies were formed. All erosion occurred in rills or small crooked channels.

The "erosion pavement" formed by sheet erosion is quite analogous to the "desert pavement" formed by wind erosion in the arid regions. Figure 4 shows a complete desert pavement on the Palo Verde Mesa, formed by wind erosion of a sandy loam which contained considerable gravel but not sufficient to be classed as a gravelly sand loam. The fine material was blown away, the gravels accumulating until they covered the surface and markedly reduced or prevented further erosion. The low content of gravel in the original material indicates that a depth of at least two feet had been removed to accumulate the pavement shown in Figure 4.

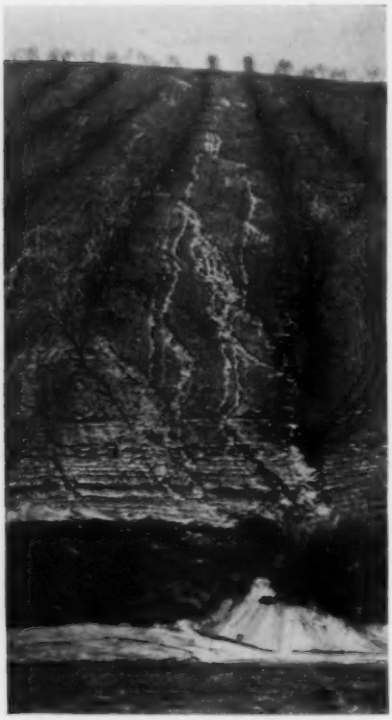


FIG. 5—Erosion in almond orchard, San Luis Obispo County, California. Ten to thirty per cent of the area was denuded of its surface soil, stripped off down to the "plowsole." The soil was a clay loam with no coarse particles, and no erosion pavement was formed. Subsequent cultivation obliterated evidence of this erosion.

Erosion pavements can be formed only when the original soil contained the necessary coarse fragments. Sheet erosion is always inconspicuous; and, if coarse materials are not available to form this type of evidence, its effects may go wholly unnoticed. This is true even in cases as extreme as that shown in Figure 5, in San Luis Obispo County, California. This hillside almond orchard is on a fine-textured clay loam with a clay subsoil. The continuous cultivation, often done soon after a rain when the soil was quite moist, had developed a definite "plowsole," or layer of compact puddled soil, that markedly retarded the downward movement of water. A heavy rain, characteristic of the occasional precipitation of that rather dry region, gave a run-off that cut numerous small erosion channels from one inch to a foot or more in width, stripping away the surface soil down to the "plowsole." In the portion of the orchard shown in Figure 5 the combined width of these channels often exceeded twenty-five per cent of the width between tree rows, and throughout the orchard it averaged well over ten per cent. From ten to twenty per cent of

the surface soil was washed away by this one storm; yet, after the first cultivation a few days later, no evidence of this loss could be seen.

Where the soil mass contains some stone, gravel, or coarse sand such evidence of erosion is not lacking, as these coarse fragments accumulate on the surface after any rain. This accumulation is caused by sheet or rill erosion, which washes the finer material *off* the surface, and by the percolating waters which may wash some fine material *into* the soil. This accumulation of coarse material to form a protective covering over the soil is designated an "erosion pavement." It is definite evidence of the activity of sheet erosion in the denudation of that surface.

THE GEOGRAPHICAL MUSEUM

Benjamin Semenov-Tian-Shansky

State University and Central Geographical Museum, Leningrad

THE Central Geographical Museum in Leningrad has this year (1929) celebrated its tenth anniversary. It may therefore be a not inopportune moment to discuss some general principles regarding the construction of geographical museums, using in illustration the experience of myself and my collaborators in the Leningrad Museum.

At the time of the great German geographers, Alexander von Humboldt (1769–1859) and Karl Ritter (1779–1859), the ideas of geographical science and its methods of investigation were fairly clear, if somewhat different from those of today. In this same period, exactly one hundred years ago, the great Russian writer Gogol first emphasized the need of a close connection between geography and graphic art. One might have expected the geographical museum to follow. That it did not is to be ascribed to various causes. In the first place, after the death of Humboldt and Ritter there began a great specialization in the natural sciences which constitute the foundation of geography, and little by little the opportunity for geographical synthesis was lost. Indeed, by 1881 among the assembled geographers of the International Geographical Congress at Venice we see much confusion as to objects and methods of geography.

In the second place, in the time of Humboldt and Ritter cartography was little developed. Even the greatest geographical works often were not provided with maps. Photography was in its early stage, and graphic representations of the geographical landscape were still very conventional and unrealistic while reproduction in color was entirely unknown.

Furthermore, the rapidly growing museums of the various branches of natural history and the humanistic sciences devoted their attention exclusively to the exhibition of material articles in accordance with their natural classification, paying no attention to geographical distribution or explanatory maps or geographical pictures. They were needlessly one-sided and, confined to their narrow specialties, with the exception of the art and zoölogical museums, they were visited almost exclusively by the specialist. Thus the geographical aspects of museum exhibition, from being neglected, became discredited; and for a long time the idea of a geographical museum entirely lacked support.

The Idea of a Strictly Geographical Museum

Towards the end of last century the great countries of the world began the practice of holding special exhibitions, some of them international, some local in character. Such were the World's Columbian Exposition at Chicago in 1893 celebrating the four hundredth anniversary of the landing of Columbus; the All-Russian exhibition in Nijni Novgorod in 1896; the International Exhibition in Paris in 1900. At these exhibitions there was some attempt to illustrate the geographical features of the countries concerned as well as their industrial character, for instance, the Russian section in the Chicago and Paris exhibitions and the Asiatic section in the Nijni Novgorod exhibition which were organized by the Russian geographer, P. P. Semenov-Tian-Shansky (1827–1914), pupil of Ritter. The exhibitions, however, suffered the disadvantage of being only temporary, while the inevitable advertising and competition detracted from quiet and objective exposition.

In 1901 V. J. Lamansky (1833–1914), ethnographer and historian, in planning the establishment of the ethnographical section of the Russian Museum, first called attention to the importance of establishing in Russia a permanent museum of the geography of man. But his idea, ardently supported though it was by P. P. Semenov-Tian-Shansky and Professor D. I. Mendeleev, was not appreciated, and this section of the Museum was organized on conventional lines. Not long before the Columbian Exposition at Chicago the idea of a permanent museum in a natural setting had been conceived in Sweden: this was Skansen, founded privately by A. Haselius in 1891.

At this time the geographers in several countries, roused by the disrepute into which geography seemed to have fallen, revived the question of its nature and scope, and a solid theoretical base for the subject and thus for the establishment of the geographical museum began to be laid. In particular I may cite the work of W. M. Davis (1906) in the United States, H. R. Mill (1894) in England, Alfred Hettner (1905) and Ewald Banse (1912) in Germany, Paul Vidal de la Blache and Emmanuel de Martonne (1909) in France, E. Chijov (1896), A. Yazilov (1905), L. Berg (1915), J. Lukashevich (1917), and myself (1915) in Russia. The "geographical landscape" idea of Hettner proved a fruitful concept for the geographical museum. I myself have applied my hexagonal scheme of geography which keeps the scope of the museum within strictly geographical limits. By this scheme the museum must confine itself to illustrating in order the distributional relations of (1) land and water, (2) land and air, (3) water and air, (4) land and plants, (5) water and plants, (6) air and plants, (7) land and animals, (8) water and animals, (9) air and animals, (10) plants and animals, (11) land and man, (12) water and man, (13) air and man, (14) plants and man, (15) animals and man.

FIG. 1

FIG. 2

FIG. 1—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of Fenno-Scandia.

FIG. 2—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of the Circumbaltic-Glaciated Region.

FIG. 3

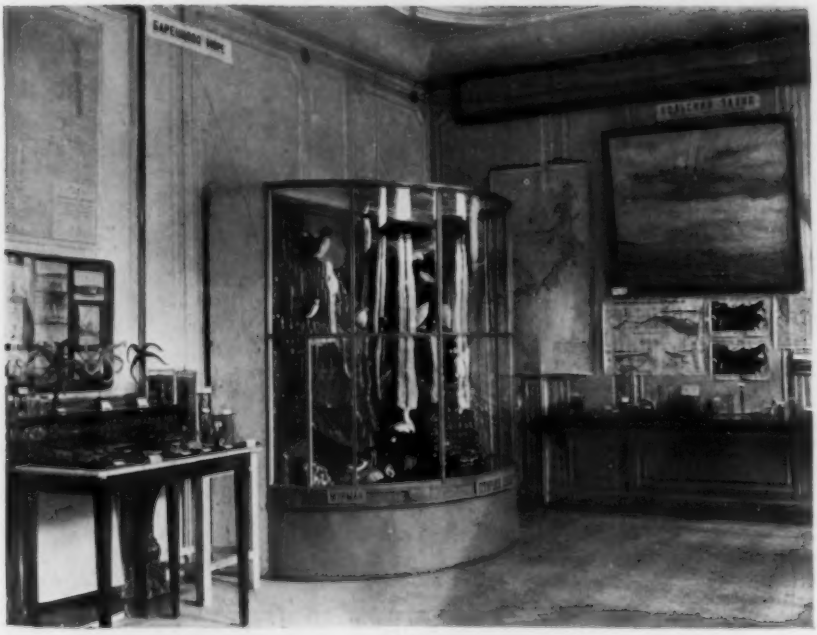


FIG. 4

FIG. 3—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of Forest-Steppe and Steppes.

FIG. 4—Central Geographical Museum in Leningrad. Section of the Sea and Fresh-Water Basins. A part of the hall of the Boreal Seas.

The Geographical Museum in Leningrad

In 1919 at the general museum conference held in Leningrad Professor A. Borsov proposed the establishment of strictly geographical museums at Moscow and Leningrad. He was desired to undertake the founding of the former, and at his suggestion the latter was entrusted to me. Borsov began to get collections together, but the transfer of the seat of government to Moscow and the overcrowded state of that city have not permitted housing of the museum up to the present time. By contrast there was no difficulty in obtaining accommodations in Leningrad because of the depopulation of the city and the abandonment of many large buildings. At first, with my colleagues, I thought of creating something like the Swedish Skansen, the "open air" museum, and the government accordingly assigned us the unoccupied palace of the late president of the Russian Geographical Society, Grand Duke Nicholas Mihailovich Romanov, situated some fifteen miles from Leningrad on the shores of the Gulf of Finland. Topographically the location was very favorable, and organization of the museum and geographical park was begun. But communication with the city was difficult, and the government would not assume the burden of further financial support. Orders were received to remove to the city, and there we settled in a small unheated and unlighted building, giving up the idea of the geographical park. Furthermore, funds for the maintenance of the museum were so curtailed that in 1923 we had available for scientific expenditure only $9.00 monthly and for house expenses only $5.00. The first years (1919–1922) coincided with the famine period, and it was difficult to work. One of our collaborators died of starvation; two others had typhoid fever, from which one died. Nevertheless the museum began to grow so fast that it has been obliged to move into a building three times the size. Funds have been increased, though still they can hardly be described as ample, amounting to about $8000 a year including the salaries of the staff, now numbering 12.

Contents of the Museum

At present the Central Geographical Museum has more than 3500 objects and over 3000 maps and books, most of them received as gifts from scientific societies and individuals. Maps, together with cartograms, diagrams, sections, etc.; pictures, panoramas, sketches, and photographs afford the best illustration of the geographical landscape and of man's activity therein; therefore they compose the main contents of the collections. Natural history and ethnographical objects are auxiliary, explaining details of the landscape shown by the maps and pictures; they occupy only a secondary place. Thus the geographical museum is distinguished from other museums by

a picturesque and original air of its own. Much of the material, cartographical and pictorial, is new and unique. A good deal I have made myself. It is especially difficult to find true and artistic pictures in color. I tried two experiments in 1921, both of which proved successful. A photographer and an artist accompanied me to Karelia and made the desired sketches of this region. I have also made enlargements in colors of autochromes brought by geographers from other regions. The Central Geographical Museum has already exercised an influence on other museums of Leningrad—geological, mineralogical, ethnographical. They have lately started to provide themselves with pictures and maps in their own fields.

Of essential importance in the Geographical Museum is the systematic scientific catalogue. To each geographical region is devoted a separate section in which is provided a detailed explanation of the contents and meaning of each object exhibited. Two sections of the catalogue have already been made and will be printed as soon as possible, that is as soon as the Museum has the necessary funds.

The political and administrative boundaries of the countries of the world are in large part distinctly artificial and more or less temporary, often not coinciding at all with the natural features. For instance, the naturally swampy region of Polesie, entirely populated by White Russians, is divided by the political boundary between the U. S. S. R. and Poland. But, as our Geographical Museum is concerned only with the natural landscape in its relation to man's activity, not a single map in the Museum shows the political or administrative boundaries but only the physiographic regions, according to the terminology of W. M. Davis, inclosed in permanent physical boundaries. It is mainly the territory of the U. S. S. R. that is represented; but for comparative purposes we must sometimes cross the borders, and it is the intention of the Museum to extend this comparative study to America. In this respect, however, I must regretfully remark that material is still very scarce. The physical regions according to which the contents of the Museum are disposed are approximately those shown in the map of "The Natural Landscape" in my article "Russia: Territory and Population," published in the October, 1928, number of the *Geographical Review* (p. 619).

So far the Museum is divided into two main sections: (1) the land and (2) the sea and freshwater basins. In the latter, in addition to the exhibition of the geographical characteristics of the seas adjacent to Russian territory, general oceanography is presented and methods of oceanographical research with the exhibition of instruments. With removal of the Museum to more ample quarters it will be possible to expand the auxiliary sections. These are: (1) theory of geography (drawings and schemes); (2) history and methodology of regional divisions (maps and tables); (3) history and methodology

of the geographical map (maps, lithographic stones, machinery, etc.); (4) conservation (pictures, photographs, maps, natural history objects); (5) technique and method of scientific expeditions (tents, packs, equipment, instruments, outfit, diary, route maps, portraits of famous travelers); (6) methodology of geographical research of small regions (instruments, models, maps, graphs, schemes, tables, samples of collections, etc., and portraits of famous geographers), this section being organized by the geographical students; (7) scientific motion pictures with films of various expeditions, rotatory panoramas of the artist, Dr. Piasezky, and the hall for lectures; (8) library and map collection.

The Geographical Museum in the Future

Recently geographical museums have begun to appear in other countries also; I am not however acquainted with the principles on which they are based. Further information about museums of this kind in geographical papers is to be desired.[1] The ideal of the future undoubtedly is a general geographical museum of the whole earth created by international coöperation of geographers. It should be established in some appropriate natural setting. It would be good to devote to it an entire island of varied relief laid out on a grand scale as a geographical park in which separate buildings, encircled by characteristic natural vegetational formations, would house the permanent exhibitions of the entire physical (not political) divisions of the globe. The prototype of such a park, it may be said, already exists in the botanical garden of subtropical flora near Batum, which was laid out according to the plans of the geographer, the late Professor Krasnov. He had an idea, similar to that of Skansen, of settling representatives of the various tribes in their natural surroundings, but financial difficulties prevented him from putting his plans into effect. In our world museum representatives of the fauna and of the human occupants of the regions should also be installed. Where climatic conditions are naturally too different, artificial heating or refrigeration would be resorted to.

Such a museum undoubtedly would be a place of pilgrimage for educated men from all the corners of the earth; and it would be the best school of geography on our planet. How can the ideal be realized? It is hard to say; but, if man has built great planetariums representing the whole of the skies of both hemispheres, we may at least hope that our ideal of a graphic representation of the whole earth in one place is not beyond the bounds of possibility.

[1] Since this article was written accounts of the geographical museum in Leipzig have appeared in the *Geogr. Zeitschr.*, Vol. 35, 1929, pp. 40–44, and *Geogr. Anzeiger*, Vol. 30, 1929, pp. 42–46.

THE GEOGRAPHIC DISTRIBUTION OF INVENTIVENESS

Mark Jefferson

THE first attempt to estimate the relative place of the countries of the world in civilization was made by the writer in 1911 on the data they themselves reported for schooling, commerce, railways, and mails.[1] It found the nations falling into four culture groups which were distinctly regional and were called Teutonic, Mediterranean, Levantine, and Oriental from regions of typical development. Canada, the United States, Australia, and New Zealand were Teutonic of culture, like their mother lands; just as Cuba and the Argentine in South America were Mediterranean, like Spain. Japan, adopting Occidental culture for more than half a century, had attained to a Mediterranean grade.

The civilization, or culture, of the study was frankly Western, European, and mechanical—the culture that actually dominates the earth. An Oriental culture has long existed which is incommensurable with this and not reducible to quantitative expression. Of the three greatest peoples of the East, Japan has frankly adopted Occidental ways, China would like to adopt them if she knew how, and India must acquire them before she can take much part in controlling her own destinies.

In Europe contiguity means similarity of culture. The Netherlands and Belgium both rank high, Bulgaria and Rumania both low. Austria-Hungary, grading 5 between Switzerland 10 and Rumania 3, broke apart in the World War; and a preliminary study for 1925 reveals Switzerland 10, Austria 6, Hungary 3+, and Rumania 2−(Fig. 1). The new study uses five new criteria, of which inventiveness proved the most interesting as soon as the significance of patent reports was perceived.

Inventiveness

In civilized countries nowadays patents afford a record of inventions, but these patents are very modern things. Man has been inventing things since the dawn of humanity. Civilization in our western sense may be said to be an integration of human inventions. But until recently inventions had an anonymous character as if mankind, not men, invented them. Only admitted and confessed legends made any pretense of naming the inventor of any important tool.

[1] Mark Jefferson: The Culture of the Nations, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 241–265.

Who devised the plow, the ax, the chisel, the hammer, the saw, the nail, the screw, the earthen pot, the twisted thread? There is no likelihood that any one person acquired power or wealth among his fellow men by inventing any of these things.

The World's Patents

Inventions began to acquire real importance to their creators when steam was substituted for muscle as motive power, with enormous resultant increase of wealth for the individuals who controlled the new processes. It is at this point of man's history that patents for inventions began to be issued and recorded. Before 1870 less than 400,000 patents had been granted in all the world. Now the number of patents has become 5,000,000. They provide an admirable means of comparing the inventiveness of different nations.

But patents are not inventions, nor are their numbers equivalent. Very likely our five million patents cover much less than a million inventions. Whoever invents something that he is persuaded will sell widely, if he can get the means to manufacture it, will take out patents on it in as many different lands as he believes offer him a possible market. So some American patent issues are made to American inventors and some to foreign inventors who have patented their ideas at home and seek patents in the United States also, among a number of additional countries. Each country issues patents both to its own nationals and to residents of other lands. Patents are matter of many international agreements and conventions. Procedure is usually the same for any applicant. It is merely provided that if he is a foreigner he must have somebody in the land where the patent is issued to represent him. The patents to foreigners are surprisingly numerous. Most countries grant more patents to foreigners than to their own people. The United States, the Soviet Republics, and Germany are the only countries that in 1925 issued more than two-thirds of their patents to the home inventors. There are but four others—Japan, France, Denmark, and the United Kingdom—to issue more than half their patents to their own people.

Records have been assembled for 1925 of 180,000 patents issued in thirty-two countries. Twenty-five of these issued more than half their patents to folks abroad. For instance, Canada granted 7891 patents to "residents of the United States" and 1292 to residents of Canada. Officials point out that "residents of the United States" are not necessarily Americans. They might be Canadian, British, or German. That is true: some of them are, no doubt, but it is also true that most of them are American firms or American individuals with an invention that they wish to market in Canada as well as in the United States, where they have patents already. Of course, the

7891 patents referred to are not an indication of Canadian inventiveness. They merely show that Americans regard Canada as a desirable market. Canada grants 85 per cent of her patents to nonresidents. Belgium grants 74 per cent of hers abroad. That the United States, of all reporting countries, issues the smallest proportion of her patents abroad—eleven per cent—is probably due to our remoteness from

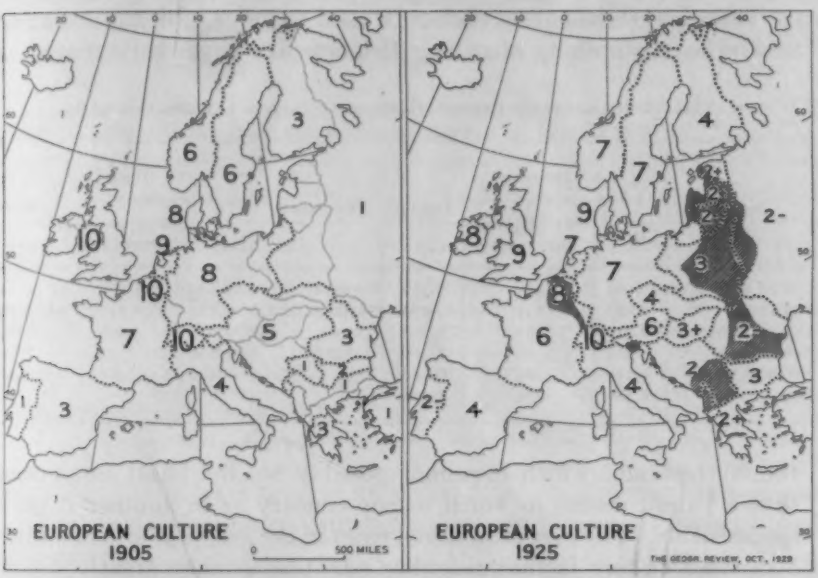


FIG. 1—Comparative culture of the European nations in 1905 and 1925. The indices for 1905 are based on statistics for schools, commerce, railways, and mails: the indices for 1925 on schools, commerce, railway mileage, railway freight, mails, automobiles, telephones, cities, patents.

other continents and lack of intimate international relations. The country that comes nearest to the United States in this respect is Soviet Russia, very low in inventiveness and not just now a good place for foreigners to exploit patents, because of her unsocial behavior among the nations of the world.

INVENTION ACCOMPANIES TEUTONIC CULTURE

The achievements of the age of machines have been especially concentrated in western Europe and eastern North America, the regions of the two great railwebs. There "every field, every factory, every forest, every mine, every village, and every home in all this region is within easy reach of railway transportation, the agency that for the century past has done more than any other single one of man's inventions to transform human life, especially in the way of pushing backward people forward and lifting submerged classes. The old-fashioned peasant, clinging closely to the ways of his fathers, and

accepting a status of inferiority, has disappeared here before the whistle of the locomotive and the rustle of the newspaper."[2] Most of the recorded patents—83 per cent of those of 1925—have been granted in the United States and Canada and the belt across Europe from Ireland to Italy—Britain, the Netherlands, Belgium, France, Germany, Switzerland, Austria, Hungary, and Italy, on the two opposing sides of the northern North Atlantic.

However, these figures cannot be used to judge national inventiveness. To say nothing of calling Belgium five times as inventive as

TABLE I—NUMBERS OF PATENTS GRANTED IN 1925 IN LEADING COUNTRIES

COUNTRY	AT HOME		ABROAD	COUNTRY	AT HOME		ABROAD
	TOTAL	PER MILLION POPULATION			TOTAL	PER MILLION POPULATION	
United States	43,904	382	5,347	Germany	11,653	186	4,224
Canada	1,292	139	9,709	Switzerland	2,112	542	2,707
United Kingdom	8,556	191	8,610	Austria	1,605	239	1,675
Netherlands	368	49	1,280	Hungary	761	91	1,750
Belgium (1927)	2,211	283	6,641	Italy	6,162	152	7,800
France	10,740	264	7,260				

the Netherlands, which it cannot possibly be, the basal assumption that a patent means as much in one country as in another is quite inadmissible. The best established tenet in the geographic distribution of human culture is that neighbor countries cannot greatly differ.[3] Culture is most contagious, and neighboring countries are fully exposed to each other's progress. Culture indices for England 10, the Netherlands 9, Belgium 10, Germany 8, and France 7 make sense. So at the other end of Europe do Greece 3, Turkey 1, Bulgaria 2, Rumania 3, and Russia 1.

SOME DIFFERENCES BETWEEN PATENTS

A Dutch patent, like a British one, is a very serious affair, formal and costly. Belgian and French patents are inexpensive and are so easily obtained as almost to be had for the asking. In England you apply on a stamped blank costing £1, and on another stamped blank costing £3 you describe your invention so fully that a competent workman can construct it without further help. If a drawing is necessary for him, you must supply it and make it according to definite instructions. Then officials make a search of British records for the last 50 years, to make sure that you are not obviously repeating or invading

[2] Mark Jefferson: The Civilising Rails, *Econ. Geogr.*, Vol. 4, 1928, pp. 217–231; reference on p. 217.

[3] Jefferson, Culture of the Nations.

another patent, and notify you that your application is accepted or refused—rather more being refused than accepted every year. Next, the description is printed in the official journal *Patents*. This gives interested parties a chance to oppose your patent if you are invading their rights. If all goes well, 18 months after your application the patent will be "sealed" to you on payment of another £1, and you may keep it in vigor for 16 years by advancing annual payments up to £16 for the 16th year. The first four years in England cost you $24, in Belgium $5. The whole British term of 16 years would cost

TABLE II—RANK OF COUNTRIES IN INVENTIVENESS IN 1925 AND NUMBER OF PATENTS PER MILLION POPULATION GRANTED ABROAD TO THEIR RESIDENTS

RANK		NUMBER	RANK		NUMBER	RANK		NUMBER	RANK		NUMBER
1	Switzerland	930	11	Belgium (1927)	180	25	Latvia	8	5	New Zealand	257
2	Sweden	299	15	Czechoslovakia	108	26	Bulgaria	7	12	United States	160
3	Austria	298	16	Hungary	68	27	Rumania	5	13	Australia	146
4	Germany	271	17	Italy	42	28	Poland	5	14	Canada	121
6	Denmark	236	18	Finland	40	30	Lithuania	4	28	South Africa	17
7	Netherlands	233	19	Spain	21	32	Portugal	2	21	Argentine	10
8	Norway	229	22	Yugoslavia	9	33	Turkey	0.9	29	Mexico	4
9	France	195	23	Greece	9	34	U. S. S. R.	0.6	31	Japan	3
10	United Kingdom	188	24	Estonia	9				35	India	0.5

you $636; the Belgian term of 10 years, $79. In Belgium there is no scrutiny or publication of your invention, and almost all applications are granted.

In 1925 there were 84,000 applications for patents in Washington: less than 50,000 were granted. In London there were 33,000 applications, and 17,000 were granted. In Germany 65,000 applications, 14,500 granted; in Switzerland 3702 applications, 2707 granted. In Belgium 8504 patents were applied for and 8370 issued. In France the applications numbered 18,443, the patents issued 16,500. Certainly one patent is not the same thing as another.

INVENTORS' FOREIGN PATENTS

When inventors apply for patents in other lands than their own they stand side by side with other nationals, meeting identical conditions. Residents of the Netherlands, in 1925, obtained a total of 1737 patents in other lands than their own; residents of Belgium a total of 1559, doubtless in much the same countries. These numbers are strictly comparable. Of every million Dutchmen, 233 obtained patents in foreign countries; and 180 Belgians in every million Belgians.

The comparison of patents issued in other countries than their own, besides putting all inventors on the same footing as far as the cost and trouble of obtaining a patent are concerned, has the further

TABLE III—NUMBERS OF PATENTS GRANTED IN 1925†

COUNTRY GRANTING PATENT	COUNTRY OF RESIDENCE OF PATENTEE																		
	Argentine	Australia	Austria	Belgium	Bulgaria	Canada	Chile	Cuba	Czechoslovakia	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	India	Italy	Japan
Australia	5	1,151	5	13	—	20	1	—	3	12	—	1	68	95	—	5	3	14	5
Austria	—	5	1,175	23	—	4	—	—	158	13	—	2	104	1,015	—	70	4	66	4
Belgium (1927)	6	29	103	2,211	—	20	—	2	76	92	—	2	1,669	1,717	2	37	3	151	9
Bulgaria	—	1	24	10	43	1	—	—	7	—	—	—	24	46	—	9	—	6	—
Canada	6	128	46	25	—	1,292	2	4	11	19	—	1	185	276	—	4	5	31	11
Chile	10	—	—	—	—	—	46	—	—	3	—	—	15	15	—	—	—	—	—
Czechoslovakia	—	6	187	37	—	—	—	—	769	22	—	3	249	927	—	36	—	46	—
Denmark	2	5	12	11	—	—	—	—	9	776	1	4	55	254	—	6	—	7	—
Estonia	—	1	7	1	—	—	—	—	—	3	59	4	17	69	—	1	—	—	2
Finland	—	2	9	1	—	—	—	—	4	19	—	163	25	114	—	3	—	12	—
France	—	73	127	347	—	43	—	—	198	90	—	16	10,740	1,585	3	43	—	420	40
Germany	4	25	247	124	3	111	4	—	204	61	1	8	763	11,653	—	75	1	174	11
Hungary	—	—	*185*	*30*	*10*	*2*	—	—	*80*	*10*	—	*10*	*136*	624	*30*	761	—	*108*	—
Italy	14	64	331	179	*10*	19	—	—	140	55	*1*	*5*	1,677	2,161	*10*	70	7	6,162	—
Japan	—	14	*8*	*10*	—	*13*	—	—	*4*	*12*	—	—	145	214	—	*6*	*11*	24	3,590
Netherlands	—	17	28	69	—	6	—	—	35	24	—	2	102	367	—	5	—	15	3
Newfoundland	—	1	2	—	—	4	—	—	—	—	—	—	—	2	—	—	—	—	2
New Zealand	1	98	—	1	—	4	—	—	—	3	—	—	7	7	—	—	1	1	1
Norway	—	10	21	18	—	7	—	—	22	56	—	9	86	278	—	8	—	16	2
Poland	—	—	113	34	—	—	—	—	109	13	—	—	175	668	—	33	—	31	3
Sweden	1	16	20	26	—	10	—	—	16	64	—	8	76	308	—	6	2	19	1
Switzerland	—	12	90	89	—	4	—	—	78	31	—	3	380	1,180	1	20	—	116	3
United Kingdom	18	165	163	208	—	146	—	4	155	109	1	20	1,022	2,271	1	43	33	225	42
U.S.S.R. (Russia)	—	1	36	9	1	—	—	—	21	5	1	37	30	889	—	9	—	18	2
United States	34	181	66	71	—	798	3	37	47	60	—	5	541	1,296	—	23	3	97	46
Yugoslavia	—	—	92	7	1	*5*	—	—	72	4	—	1	78	212	*1*	24	—	35	—

† Figures in italics are estimates.

advantage of extending our sources of information. From Spain, for instance, we have no report. Its patent office contents itself with affirming in the *Anuario Estadístico de España* that, in 1925, 3935 patents were granted, 3 denied, and 689 expired. However, other European countries enumerate the patents they have granted to residents of Spain, and from these totals the required number for Spain can be arrived at. There were 136 granted in France, 55 in the United Kingdom, 77 in Italy, 37 each in Belgium and the United States, 19 in Germany, and so on to a total of 400. Those are the facts for Spain, obtained without any Spanish report. From the reports of twenty-five patent offices we gather the facts we need for thirty-five different countries. Spain and Portugal, Latvia, Lithuania, Greece, and Turkey provide no available statistics; but we have their patent data from the countries where patents are granted to their nationals. So with Mexico and the Argentine Republic. These data,

NUMBERS OF PATENTS GRANTED IN 1925†

Country of Residence of Patentee																		Country Granting Patent
Mexico	Netherlands	Newfoundland	New Zealand	Latvia	Lithuania	Norway	Poland	Portugal	Rumania	South Africa	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	Soviets	Yugoslavia	
—	18	—	110	—	—	7	1	—	—	10	2	20	17	—	570	506	12	—	Australia
1	66	—	—	—	—	17	4	—	4	4	1	47	165	—	137	201	1	11	Austria
2	235	—	10	1	—	41	24	—	5	2	37	117	302	—	710	873	6	3	Belgium (1927)
—	7	—	—	—	—	—	—	—	3	—	1	—	9	1	7	[illegible]	—	—	Bulgaria
2	47	1	44	—	—	36	2	—	—	20	5	78	70	1	732	7,891	—	2	Canada
—	5	—	—	—	—	—	—	—	—	—	—	6	4	—	11	80	—	—	Chile
—	54	—	—	—	—	11	5	1	2	—	8	82	114	—	185	237	2	3	Czechoslovakia
—	37	—	2	2	—	40	2	—	—	1	1	62	22	—	74	89	1	—	Denmark
—	14	—	—	3	—	—	—	—	—	1	—	9	3	—	10	7	—	—	Estonia
1	17	—	—	—	—	19	1	—	—	—	—	110	[illegible]	—	14	19	—	—	Finland
—	181	—	14	—	—	58	24	4	14	—	136	150	635	3	1,361	1,503	[illegible]	3	France
5	119	—	[illegible]	6	2	52	29	1	[illegible]	4	19	177	605	2	523	[illegible]	13	[illegible]	Germany
—	110	—	5	—	—	10	10	—	10	—	10	20	50	—	200	100	—	20	Hungary
—	153	—	13	—	—	54	9	—	14	3	77	126	583	—	974	986	5	27	Italy
—	28	—	6	—	—	5	—	—	—	—	—	33	[illegible]	—	339	540	—	—	Japan
—	384	—	—	—	—	16	—	—	—	3	3	65	113	—	226	157	—	—	Netherlands
—	—	3	—	—	—	2	—	—	—	—	—	1	—	—	17	26	—	—	Newfoundland
—	5	—	200	—	—	1	—	—	—	1	—	3	2	—	93	60	—	—	New Zealand
—	47	—	1	—	—	480	—	—	—	3	3	167	58	—	122	187	—	—	Norway
—	61	—	—	—	—	[illegible]	510	—	4	—	1	37	27	—	80	110	1	2	Poland
4	51	—	4	—	—	66	3	—	—	7	4	687	64	—	157	303	2	—	Sweden
—	105	—	1	2	—	26	7	—	1	—	17	37	2,112	—	238	250	—	6	Switzerland
2	207	—	65	—	—	52	9	—	4	48	55	209	396	1	8,556	2,867	20	5	United Kingdom
—	57	—	—	3	1	4	1	—	1	—	11	46	3	—	72	82	6,044	—	U.S.S.R. (Russia)
39	70	—	56	—	—	53	3	—	1	24	19	156	221	1	1,344	43,904	3	2	United States
—	20	—	—	—	—	9	—	—	3	—	—	10	20	—	42	50	—	106	Yugoslavia

† Figures in italics are estimates.

shown in Table III, are entirely new. They have been collected from printed reports and direct communications from patent offices in many lands. Our consuls everywhere have been of the greatest assistance in collecting them. The figures are for 1925 except those for Belgium.[4] Russian data were supplied by the Amtorg Trading Corporation in New York in the form of numbers of patents granted to the residents of various lands from October, 1924, to October, 1927. A third of each of these values has been assumed to be the approximate value for 1925. Sometimes it was difficult to ascertain the numbers of patents granted by countries, as that annotation is made only on the applications. This was the case for Denmark; but, the applications numbering 2733 and the patents granted 1465,[5] the number of applica-

[4] By an error of a clerk employed to extract the Belgian data from the patent office records—as Belgium neither publishes nor compiles the issues by country of residence—the record for that country is all for 1927.

[5] Letter of Mr. Chas. Hude, patent attorney of Copenhagen, July 11, 1927.

tions from each country has been multiplied by .54, the ratio between these two numbers. Similar treatment had to be given the New Zealand figures.

How many patents, however, were granted to the French or the English in Spain or Portugal, or any other of the countries for which no statistics were obtainable? Estimates could often be made. It has been possible to check these estimates in some cases, and they have been shown to be reasonably good—as the instance of belated data from Austria and Bulgaria shows.

Extra-European Countries

The United States is at a disadvantage by reason of its lack of reports from neighboring countries. It has not been possible to obtain reports from twelve of the fifteen American countries to whose residents our patent office grants patents. We issued 130 patents to these twelve countries in 1925. Remembering our great excess of population over our neighbors, which was no doubt the reason why Canadians obtained but 798 patents at Washington while Americans obtained 7891 at Ottawa, it is certain that many hundred, perhaps a thousand or more patents were taken out by Americans or American firms in Mexico, Cuba, and other Latin American countries which report "data not available" when applied to from this distance. All told, twenty-one of the fifty-one countries to which we issue patents are not represented in our reports.

In this respect New Zealand fares better. She grants patents to residents of Australia, Belgium, Canada, Denmark, France, Germany, the Netherlands, Italy, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States, all of which have reported. She also grants patents to the Argentine Republic and India, from which no reports are at hand—two countries not reporting out of a total of sixteen. As the two countries get only one patent apiece in New Zealand, the missing numbers are not likely to be of importance. Even in the case of the United States the missing numbers would hardly raise the index of invention per million citizens more than to 170 or 180 (for whites only, say 190 or 200).

Perhaps the New Zealanders have more of one quality called for by high indices than have the people of the United States. A man must have, I suppose, a certain extranational-mindedness to be led to take out a patent in a foreign country. We have so vast a country with so great and rich a market, such freedom from tariff barriers throughout its extent, freedom from language barriers, and from national barriers for thousands of miles that we have not learned to look abroad for business. Our participation in international trade is very small, $78 per capita in 1925, while 26 European countries aver-

aged over $90. We had a low commercial index in 1905 and again in 1925. Norway, Sweden, Denmark, Austria, Switzerland, the Netherlands, France, Belgium, and the United Kingdom all excel us in this respect. We do a huge amount of buying and selling within our own country, probably more than the people of any other land, but not much commerce across frontiers. Our tariffs have never encouraged trading abroad. We have a minimum of contact with foreign peoples; and, since the passing of the clipper ships, we have not had much opportunity for such contact, that is away from the great port cities which are not so much America as the anteroom to America.

We are a people of one language as few European peoples are. The great masses of our native-born citizens are unfamiliar even with the sound of other tongues than their own. Probably we have a smaller proportion of persons who know another language than the mother tongue, a very large part of those who do being the foreign-born, a generation that is passing away. Even in the gross we do not visit other countries as much as Europeans do. In Switzerland, for instance, travelers from America are still fewer in total number than travelers from Germany and, in proportion to our numbers, of course fewer still. In Switzerland the natives use three important languages in all the affairs of life; and a considerable class of business and educated men are familiar with still other languages, such as English. All of these considerations make intercourse with foreigners easy and natural to nations like the Swiss and difficult for us. This creates in us a certain aloofness and disinclination to international undertakings like a World Court or a League of Nations. It is not that we are wanting in generosity or sympathy with others, for these sentiments are highly developed in the United States and the national prosperity and wealth permits their exercise: it is that we lack habitual intercourse with foreign nations and acquaintance with foreign ways.

Certainly these considerations account in part for Switzerland's enormous lead in patent grants. So, too, of Austria's long association with Hungarians, Czechs, Ruthenians, and Croats. So, too, of the Scandinavians. Two millions, three millions, and six millions of people in three neighboring nations understand each other fairly well, if they do not like each other much in spite of the associations of a thousand years of contact, and do important business every day with vastly more numerous peoples around them, with whom their existence has come to be knit. Danes depend on the English to take their butter and bacon, Swedes need the London papers to consume their wood pulp. And the Dutch and Belgians alike are groups of but seven millions each doing business with forty-five million British on the north, forty million French on the west, and sixty million Germans on the east. With these people international-mindedness is a part of business and life; business and life with us keep our thoughts at home.

Internal Variation of Inventiveness

The larger countries are far from homogenous in their different sections, as an examination of home patents issued to different parts of some countries shows. This is in a measure due to the fictitious importance of the capital city, where the patent office is usually located. Paris, Berlin, London, and Washington receive much more than their share of the patents issued to home residents, merely because inventors take residence there while obtaining their patents. But Westphalia and the Ruhr take out more patents than Pomerania and East Prussia, both agricultural. In Britain, where 188 in every million get patents "abroad," 191 in a million take out a patent at home, which are very similar values. By districts there were 221 to the million in England, 88 to the million in Scotland, 51 in Wales, 51 in Northern Ireland, and 17 in the Irish Free State—the English figure being increased and the others lowered by the flocking of inventors to London as the seat of the patent office. The persistence of the Irish Free State as a part of the United Kingdom comes of the fact that their own patent office first opened for business in 1927.

In the United States there were 160 patents per million persons obtained abroad, and 382 patents per million issued to residents of the country. The home patents are reported by states. We have no data for patents granted abroad to residents of the different states, but we may use the home patents if we bear in mind that they are more than twice as large numbers as "patents abroad" (382 to 160). Connecticut leads the country, with 920 home patents per million white persons; then come California and New Jersey with 760 and 740; the southern states run down to 100 and 150. Connecticut's figure cannot be due to the crowding of inventors to take residence near the patent office. That would take them away from Connecticut to Washington.

Japanese Inventiveness

Japan seems to me much more significant in invention than her low place in the list (31st) implies. Americans, Canadians, Australians, and New Zealanders are of course Europeans by culture and blood. Their inventiveness is a leaven of European inheritance working in a new-world environment. But Japan is a purely Oriental people which has known of our Western mechanical culture for less than a century and yet gone far in mastering it. How astonishing that it should be a scientist of this race that the Rockefeller Institute for Medical Research sent to Guayaquil when appealed to for help in cleaning up that last stronghold of endemic yellow fever. It is not merely by its army and navy that Japan has commanded the respect of the world. She has made wonderful beginnings of education and industry and has an imposing merchant shipping on the ocean. Her

culture was rated in 1911 as Mediterranean, i.e. below the Teutonic countries, but her rise to that place was regarded as phenomenal, unparalleled by any Western nation. Mr. Orchard thinks she should not be called the England of the Orient because her industry is so far below the English development.[6] Not an England *in* the Orient, no doubt, but quite English *for* the Orient. If it is possible to get from the phrase a notion that Japanese industry is comparable to that of England, the words are misleading. Yet Japan is more in the lead in Asiatic industry than England is in that of Europe.

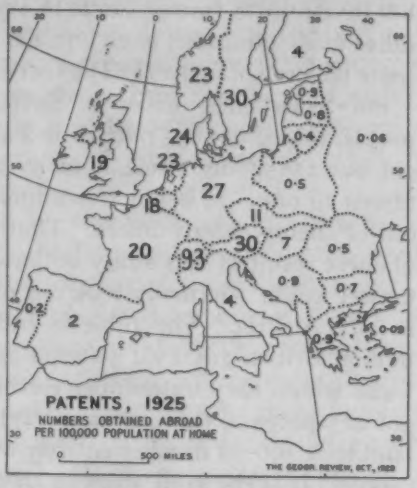


FIG. 2—The number of patents obtained abroad in 1925 by residents of European countries per hundred-thousand population.

The most singular feature of Japan's progress is that it has been accomplished by her intellectuals out of patriotism. Rulers and aristocrats have resolved to scrap their past in order to give their country a place in the world worthy of their devotion to it. The common people have not scrapped their past and have little understanding of what is happening to the national institutions. An obedience to their rulers that the West knows not is their contribution to the national accomplishments. There have been no Watts or Stephensons from Japan's lower classes to raise Japan in industry. Only a very limited class in the nation has really wrought out the wonderful transformation it has undergone. When we divide the 187 patents granted in other countries to residents of Japan by the whole population of the country we are diluting the national inventiveness by an unfair mass of unproductives. The 160 patents per million of the United States have a dilution in the negroes in our population. If we eliminate them the number might be 180 or even 190, and the Japanese inventions of three per million would be manifold greater if we could eliminate from the divisor all the Japanese who have not caught the contagion of Western culture. It would be most interesting to know the social status of the 46 residents of Japan to whom the United States granted patents, the 42 granted patents in England, and the 40 in France.

Very striking on the map that sets out the indices of inventiveness of the European peoples is the sharpness with which there rise above

[6] Compare J. E. Orchard: Can Japan Develop Industrially?, *Geogr. Rev.*, Vol. 19, 1929, pp. 177–200.

the Mediterranean countries the nations of Teutonic culture—Austria, France, Germany, the Netherlands, Belgium, Britain, Sweden, Norway, and Denmark, and, towering above all the others, Switzerland.

Swiss Leadership

What does it mean to say that Switzerland has 930 patents granted her inventors in foreign lands to every million Swiss people, while the other leading nations have but 200 to 300? Is it anything more than some trickery of figures? The facts are overwhelming. French reports —not Swiss ones—show us Switzerland, a nation of four million people, taking out 635 patents in Paris while the sixty million Germans got but 1585, only twice as many though they outnumber the Swiss fifteen to one. It is not war animosity that is keeping the Germans out of enemy patent offices. That was confidently expected; but the plainest result of this study is that sentiment is not concerned in the matter at all. Germany took out more patents in enemy France than in ally Austria. The table is full of illustrations. The forty-five million British got 1361 patents at Paris, but twice as many as the Swiss whom they outnumber eleven to one. In London the Italians got 225 patents, the Germans 2271, the French 1022, while Switzerland took 396—a number entirely out of proportion to her four million people. It is the same story in all countries: all patent offices report the Swiss as the foremost inventors.

The culture study for 1905, reasoning from schooling, commerce, development of railways, and use of the mails, gave Switzerland a slight lead among European nations, rating the order Switzerland, Belgium, United Kingdom, the Netherlands, and so on. A preliminary study of culture for 1925, with five other criteria added to those of 1905, puts Switzerland more strongly in the lead, the list ranking: Switzerland, United Kingdom, Denmark, Irish Free State, Belgium (Fig. 1).

A partial list of books published in different countries showed Switzerland to be far ahead of any other country in this sphere. In urbanization—the tendency to develop large cities that signalizes modern industrialism—Switzerland again occupies a foremost position. If by a great city we mean a city of a hundred thousand persons or more, she has four of them in a population of four million. Switzerland is highly industrialized. We have allowed the herdsman and the hotel keeper to loom too large in the Swiss picture. The Swiss import twelve dollars' worth of silk per capita, manufacture it, and export twenty-two dollars' worth per capita. Silk is America's greatest import; but even in this year 1929 it will not reach four dollars a head, and there are no exports of manufactured silk to count.

The Swiss themselves attribute much importance in the growth of

their industries to the religious persecutions in neighboring countries in the sixteenth and seventeenth centuries—persecutions which drove thousands of intelligent men, of whom many were skilled workers, into Switzerland. The revocation of the Edict of Nantes alone in 1685 is credited with driving sixty thousand Huguenots from France into Switzerland. They founded the silk industry of Zurich and Bern. It was a Huguenot who founded the watch business at Geneva. The Huguenots introduced banking and wholesaling. Spanish persecution in the Low Countries and Swiss neutrality during the Thirty Years' War added to the human resources of Switzerland. In other countries originality manifests itself in a chosen few of their people. Switzerland naturally has her own share of these together with many thousands of original, enterprising spirits from neighboring countries. It is no wonder Swiss inventiveness runs high.

The enriching of Switzerland by this addition of choice spirits was enhanced by the largeness of the French population from which they were culled and the smallness of that of Switzerland to which they were added. The persecutors of the Huguenots were in effect applying an intelligence test to their people and expelling (or slaughtering) the most promising. How curious that the American enforcement of immigration quotas had the result of cutting down a Swiss immigration of 8000 in 1923 to 4140 in 1924, effectively counting them undesirables as did the men who drove the Huguenots out of France!

How interesting it would be to accept the lesson of history and admit freely the first half million foreigners, including Mexicans and other Americans, who attained an A grading in such intelligence tests as were used in the Army to sort out potential officers from the mass of recruits. We have been described as receiving the offscouring of Europe and doubtless we do get some. Why not frame our admissions to the United States on a basis of a clean police and health record and a high intelligence test?

THE CENTRAL PLATEAU OF FRANCE: A REVIEW*

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THERE are certain treatises which instantly take high rank in scientific literature, either because of the intrinsic value of their material contributions to knowledge, or because of the excellent manner in which the authors discuss their subjects. Baulig's "Plateau Central" will for both reasons take and keep a high place in the literature of geomorphology. The subject of discussion is of prime importance—one of the great natural regions of France notable for the variety and complexity of the problems it presents. Baulig's treatment adds extensively to our knowledge of the region's physical evolution and throws new light on many of its problems. And, best of all, his treatment is clear and analytical, obviously the work of one who at every step of the long and intricate discussion knows his subject in all its phases.

Divisions of the Central Plateau

The high table-land of Central France represents a complexly folded mass of ancient rocks, mostly crystallines, which were in different localities and at different times subjected to peneplanation with subsequent burial by sedimentary beds of later date. The peneplaned basement with its sedimentary cover was profoundly broken by a network of intersecting fractures, believed to be related to uplifts of the Pyrenees and Alps. The fault blocks were tilted, raised, or lowered, with renewed erosion of uplifted blocks and accumulation of débris on depressed areas. Where erosion stripped the sedimentary cover from back slopes of tilted blocks, the buried peneplanes were resurrected to form an important element of the present landscape. Vulcanism then contributed its part, while rivers continued their destructive work, the later history of the region being largely one of successive cycles of stream erosion, modified to a slight extent by glaciation of higher altitudes.

The Central Plateau is readily subdivided into areas in which one or another of the foregoing geological events played a dominant rôle in shaping the present topography. The Limousin in the west is a vast peneplane of early Tertiary age surrounding a central monadnock mass, La Montagne, the whole little affected by dislocations or vulcanism. In strong contrast, the Auvergne and adjacent regions in the center and north consist of fault blocks profoundly displaced, some raised high with surfaces generally representing the resurrected peneplane of early Tertiary age, others greatly depressed and buried under thick accumulations of Tertiary sediments; over both were spread volcanic accumulations of vast extent, including the great cones of Mont Dore and the Cantal. The southern region is especially characterized by tilted fault blocks, like the Lozère and the Montagne Noire, with back slopes formed by resurrected peneplanes of post-Hercynian and early Tertiary date; but it also includes the vast limestone plateaus of the Causses. Along the southeastern borderland the rocks of the highlands are warped and broken downward toward the Rhone Valley and the Mediterranean shore, while erosion of the depressed weak rock cover has largely determined the plateau border; here the inclined lava plateaus of the Coiron contrast markedly with the sharp crested ridges and wild gorges of the Cévennes, carved by active stream erosion on the steepened slope.

* Henri Baulig: Le Plateau Central de la France et sa bordure méditerranéenne: Étude morphologique. 501 pp.: maps, diagrs., ills., index. Armand Colin, Paris, 1928.

It is not possible in a brief review even to mention the large number of highly important conclusions presented by Baulig respecting each of the above regions. The reader must himself follow the author through his painstaking analyses of geological history and resulting surface forms in order to appreciate the full breadth and depth of his studies.

Resurrected Peneplanes

From among the more important theses which Baulig advances two are selected for special comment. The first is that a large proportion of the upland surface of the Central Plateau consists, not of a single warped peneplane of relatively recent date, but of different peneplanes which were completed long ago, buried under later sediments, and more recently reëxposed to view through stripping away of the sedimentary cover. These peneplanes usually intersect each other at a low angle, and the nearly uniform surface of a single plateau block may consist of two distinct peneplanes. Resurrection of such surfaces presents a delicate problem to the geomorphologist, especially when the resurrected forms are profoundly dissected by later stream erosion; for it is no easy matter to distinguish a single peneplane of late Tertiary age, warped to give some variation in slope and badly dissected, from two resurrected peneplanes of more ancient date, intersecting at a low angle and badly dissected. Apparently Baulig has successfully accomplished this task at many points throughout his area, for both his evidence and his arguments seem to stand the test of critical analysis.

Erosion Cycles and the Eustatic Theory

The second of Baulig's theses selected for comment is far more radical. It is, in effect, that a large number of erosion cycles registered in the topography of the plateau and its borderlands, and covering the long period since the late Pliocene, result from eustatic shifts of sea level, the land having remained essentially stable all this time. As the author correctly points out, the eustatic theory has a value which is independent of the extent of country to which it can with certainty be applied: "It is sufficient that there should have been, at certain periods, some stable regions in order that one may correlate with these few fixed standards the evolution of unstable regions." Accordingly the leitmotif of Baulig's work, the end to which much of his argumentation converges, is to extend to higher levels in southeastern France and to confirm for earlier geologic times the eustatic theory of changes of level advocated by de Lamothe, Depéret, Chaput, and others of the French school; and he closes his treatise with the confession of his faith that just as geologic chronology reposes upon the widespread occurrence of marine transgressions and regressions, "so it may be that upon the eustatic theory, duly verified and confirmed, morphology will one day establish universal correlations."

Erosion Cycles Revealed in the Plateau Valleys

Baulig's treatment of erosion levels falls into two main subdivisions: the cycles revealed in the valleys traversing the several parts of the Central Plateau, and the "grandes surfaces d'aplanissement cyclique" found along the Mediterranean borderland. Forms of the first category are described in various chapters throughout the book in connection with accounts of different sections of the plateau. It is found that the steams repeatedly exhibit, in longitudinal profile, a succession of steeper and more gentle segments, a steeper segment often grading imperceptibly into the next portion of more gentle slope in such manner as to give a profile concave upward. These are interpreted as the result of successive rejuvenations of the stream, the deepening and steepening due to rejuvenation having been propagated headward as successive "waves of erosion." Confirmation of this interpretation is believed to be

found, in many places, in the presence of more gently graded portions of valley walls, high above present stream level, these being regarded as remnants of earlier mature valleys into which the rejuvenated stream has cut forms of a later generation. The different segments of each longitudinal profile are prolonged downstream to give the theoretical former positions of the thalwegs for each assumed cycle, the positions of the respective thalwegs being checked whenever possible by projecting appropriate facets of ancient valley walls still preserved at high levels. The various restored thalwegs on one stream are correlated with those on other streams, each being assigned to its corresponding cycle, numbered from above downwards.

It is not necessary to discuss this portion of the author's work in great detail, since Baulig himself does not seem to regard it as the strongest part of the case in favor of the eustatic theory. He rather marshals such evidence as the regions present and indicates the direction in which he believes the evidence is pointing, leaving to the erosion platforms of the southeastern border the main burden of proof. Indeed, the failure to correlate effectively the supposed cycles revealed by stream profiles in the plateau with the abrasion platforms on its border, coupled with the failure to bring out strongly the nature of the transition from one to the other and thus to emphasize their continuity of development, if such there be, seems to the reviewer a weak point in the author's argument.

But there are other weaknesses more apparent. In the introductory portion of the work, "Les Problèmes et les Methodes," the author fully recognizes that there are grave difficulties and real dangers in attempting to decipher erosion cycles from stream profiles which might be expected to contain changes of slope due to non-cyclic causes (variations in rock resistance, earth movements, stream capture, etc.). When, however, the individual profiles are examined and interpreted, it does not appear that sufficient weight is given to these difficulties. Changes of slope are accepted as cyclic in origin and assigned to specific numbered cycles, when it would seem they might equally well bear an alternative interpretation. Such an alternative interpretation is sometimes considered but rejected on grounds which appear invalid, as when it is argued that a sudden steepening of stream slope cannot have had its origin in a hard rock barrier because the break in slope does not now occur at the contact between hard and weak rock. The author in such places gives little or no weight to the fact that falls, rapids, and steepened profiles developed at a barrier will cut back into and eventually through the obstruction and may therefore be found in the midst of the hard rock zone, or in the weak rock zone next upstream, far from the contact which gave birth to them; nor does he sufficiently consider the extent to which this same history will give rise to youthful gorges cut in more mature valleys of non-cyclic origin.

In the restored profiles of supposed ancient thalwegs the proportion of known fact to theoretical reconstruction is extremely small, short remnants of actual profiles being projected through the air for great distances beyond the last trace of supporting evidence in the topography. Sometimes the restored thalwegs are carried far out above the surface of a low-lying peneplane, it being assumed that the peneplane has been developed since the thalwegs were established, or that the thalwegs were cut in an overlying weak rock cover which has since been removed by erosion. Wide variations in the angles at which the theoretical profiles are projected seem permissible without rendering them out of harmony with the small remnants of existing profiles actually observable in the field; yet even slight variations in these projections will give an arrangement of profiles requiring for its explanation a theory of origin entirely different from that supported by the author. The very assumption on which the profiles are restored—that in the same section of a supposedly "regularized" stream any given former thalweg cannot slope less steeply than earlier thalwegs nor more steeply than those of later date—seems of doubtful validity.

Baulig himself repeatedly emphasizes the delicacy of the problem and admits the

necessity of extensive interpolation and extrapolation, the absence of the supposed cyclic changes of slope on certain streams and the presence of abnormal changes of slope on others which do not fit into the cyclic scheme and require special explanation; and when, further, he is unable to establish complete concordance between the cycles of different drainage systems in the same section of the plateau, the reader should at least be as cautious and leave the demonstration of the eustatic theory to a region furnishing better evidence than does the plateau upland and its streams.

On the other hand, the reader would be ill-advised to dismiss Baulig's theory from consideration simply because it presents a picture of cyclic changes very different from that recognized by most geomorphologists. If successive cycles are propagated into a still-standing continental mass as "waves of erosion" in such manner that today a Pliocene cycle of erosion may yet be in full swing at high levels and there attacking deposits of late glacial age, with cycles of various later dates simultaneously following it inland at lower levels, so as to give erosion planes of different altitudes and different geological dates of origin, *literally produced at the same time*, it is highly important that this history be fully established and that we reëxamine Appalachian and other topography with the possibilities of this theory in mind.

Erosion Platforms of the Southeastern Borderland

So far as Baulig's treatise is concerned the case for the eustatic theory must stand or fall on the evidence furnished by the erosion platforms of the southeastern borderland, where the plateau upland breaks down toward the Rhone Valley and the Mediterranean. The author believes he can clearly distinguish three principal erosion levels: the 180-meter, the 280-meter, and the 380-meter surfaces, levels, plateaus, or cycles, as he variously calls them. Less extensive and less perfectly defined are the 150-meter and the 250-meter levels. Still lower levels are recognized, including the terraces of the Rhone Valley studied by Lamothe and Depéret; but, after an analysis which takes issue with these authors on material points, Baulig concludes that the higher surfaces, from the 150-meter level upward, are more reliable and more significant. It is accordingly upon these that he proposes to base the case for the eustatic theory.

Although the author discusses these several levels in much detail, giving a large number of specific elevations from selected localities, he does not show their extent by map or diagram. Hence the reader cannot be sure he correctly pictures the forms and their boundaries. It would appear from the text, however, that in a general way the platforms extend along the southeastern slope of the plateau border, roughly paralleling the Mediterranean and the Rhone depressions. They are described as maintaining a rigorous horizontality in this direction, although it would appear that they may slope downward from their inner toward their outer borders. The interpretation that they, or some of them, represent parts of a single warped peneplane is rejected on the ground that the forms occur in stepped series. A marine origin for the forms, previously advocated by some investigators, is excluded on the ground that the surfaces are too rugged and too systematically adjusted to drainage slopes for a plane of marine abrasion, that no sediments of marine origin are found on them, that they were developed in part in protected localities not well exposed to wave attack, and that their inner borders fail to show cliffed headlands and other shore forms. But he believes each of the platforms must have been produced close to the sea, although by subaërial processes. In age the platforms are regarded as late Pliocene and later; and because of their horizontality it is concluded that they have not been affected by earth movements during that period. Accordingly they are interpreted as the result of successive eustatic drops of sea level. To confirm this conclusion the author examines descriptions of erosion levels studied by other investigators in widely separated localities and finds a sufficient number of corresponding platforms in those places to prove, in his opinion, the validity of the eustatic theory.

There can be no doubt that Baulig has rendered important services to geomorphology in this, as in other portions of his excellent treatise. His critiques of the work of Depéret and Lamothe will be useful to all students of the problem of river and marine terraces, while his descriptions of the borderland topography and explanations of the drainage history will prove an indispensable aid to every future investigator in this region. But as to the strength of the case which the author presents for the theory of eustatic shifts of sea level opinions will doubtless differ.

Some Critical Considerations

The problem is admittedly complicated, and it is not practicable within the limits of a review to present in full the grounds which permit one, while accepting the facts stated by the author, to hesitate before adopting his conclusions. It may, however, prove useful to future students of Baulig's valuable treatise to specify here a few considerations which make the case for the eustatic theory, as presented by that author, appear unconvincing. Briefly stated, these are as follows:

1. Many essential facts necessary to a critical judgment on the merits of the case are not placed before the reader. Opinions as to the origin of the platforms, as to the accuracy with which their former and present attitudes may be determined, and other vital points must be based on more data than are offered regarding the areal extent and shape of the platforms, their exact surface form, the amount and directions of their slopes, and the extent of their preservation or of their destruction by stream erosion.

2. The method of selecting the altitude figures given for the several platforms, and especially of determining the low points for which the erosion levels or cycles are named, is not made sufficiently clear. Since methods of accomplishing this task for a partially eroded surface vary and involve variable proportions of error or personal equation, it is necessary to have a clear picture of the procedure in order to know within what limits warping of supposedly horizontal platforms may occur without being detected.

3. The mechanical regularity of the vertical spacing of the platforms (100-meters interval between the principal levels, 180, 280, 380; and 100-meters interval between the chief surbordinate levels, 150, 250) suggests that these are approximations rather than actual determinations of platform positions and raises doubts as to the accuracy with which these positions are identifiable on the dissected terrain and consequently further doubts as to the certainty with which warping or tilting of the platforms can be excluded.

4. While the platforms are said to maintain rigorous horizontality in directions parallel to the supposed ancient shore lines, the altitude figures given by the author vary so widely that it is not clear how this supposed rigid horizontality was determined.

5. Many of the supposed facts upon which the author bases important parts of his argument do not themselves appear to be adequately demonstrated. Especially open to question are his conclusions that the erosion surface beneath the Coiron lavas has not been deformed; that the régime and slope of the Ardèche and Rhone rivers have remained constant from the more ancient levels to the present; that the Rhone has fully established its profile of equilibrium; and that since the end of Miocene time the Gulf of Lyons has never had rocky shores.

6. Alternative theories are not examined with sufficient care to justify their elimination. One (the epeirogenic theory) is dismissed without discussion, on the basis of the author's personal judgment that epeirogenic movements could not raise uniformly an area hundreds of kilometers in extent. Consideration is not given to the possibility that a broad uparching of the plateau might occur in such manner as to tilt the borderland more steeply and raise its erosion platforms, yet at the same

time leave these platforms little distorted in the direction of their elongation parallel to the ancient shore lines.

7. Comparisons with other areas selected by the author for verification of the eustatic theory show that inconsistencies in platform levels are sometimes as striking, and occasionally more so, than are the cases of agreement. In some cases apparent agreement is only secured through argument (in one instance very elaborate and highly theoretical) directed to disproving the interpretations as to attitude or origin of platforms offered by those who have studied them on the ground.

8. A considerable part of the supposed confirmation of the eustatic theory consists in citations of the lower levels (below 150 meters) of Depéret, Lamothe, and others, although these were earlier explicitly excluded from the author's study for reasons apparently sound. In any case they are just as foreign to Baulig's discussion as would be the citation of his high Pliocene levels in an effort to prove eustatic movements during the early Tertiary.

Many will miss the full value of Baulig's work because in its make-up sufficient attention was not given to the highly important matter of illustrations. In all the 544 pages constituting the body of the text there are only four small diagrams, although both the subject matter and the author's manner of treating it render sketch maps and other diagrammatic representations of the facts peculiarly necessary. Surface forms, structural features, areal geology, and other important elements are described in terms of their location with reference to countless small towns or villages unknown to the average reader and not shown on any map available to him. The six large contour maps accompanying the work are of little or no help in this connection, as cities, towns, and villages are all omitted from them, no topographic features except rivers are named, and even the contour interval and altitude figures are lacking. In places the reader is aided to an understanding of the text by the plate of cross sections, but even here he is frequently baffled because most of the localities named in the text are not shown on the sections and because some of the cross sections described in the text appear to be differently located from those figured on the plate. The plate carries no explanatory legend to make intelligible the symbols employed, so the reader must turn to the descriptions of sections published in the back of the volume before he can fully understand the geological relations. Correlation between text and illustrations is very defective, a large proportion of the text failing to refer to the appropriate maps, sections, or profiles in the pocket.

For these reasons Baulig's treatise makes extremely difficult reading; to understand it fully one requires a set of large-scale topographic maps of the whole area, a corresponding set of geological maps, and patience to trace on them, step by step, the details of the author's discussion.

The reader who hurdles the difficulties placed in his path by faulty illustration lays down the volume with a feeling that he has journeyed far and most profitably with one who has given him an inspiring vision of the Central Plateau and its problems. The strength of the work depends upon the sureness with which the author demonstrates that geologic processes working upon geologic structures throughout past geologic time have produced the present topography. Its occasional weaknesses occur where the workings of geological processes and the results which they are capable of producing are too narrowly restricted by deductive reasoning based on an insufficient foundation of geologic fact. The work as a whole is excellent, and both geologists and geographers are indebted to the author for the valuable service he has rendered their respective sciences.

GEOGRAPHICAL RECORD

NORTH AMERICA

Some Recent Surveys in Alaska. "Topographic mapping in Alaska has been carried on in a systematic way by the Geological Survey for nearly thirty years, yet in that time less than half of its vast area has been covered." Southeastern Alaska in particular is a difficult terrain to explore because of its heavy rainfall and rugged relief. With the exception of the International Boundary, scattered mineralized localities, and the vicinity of towns little accurate information has been available, in spite of the wealth in mineral and timber resources that awaits exploitation. Here was an excellent opportunity to put aerial photographic mapping to the test; and such a test was carried out by the U. S. Navy, in coöperation with the Geological Survey and other government departments in 1926. A summary of the work is given in "Aerial Photographic Surveys in Southeastern Alaska," by R. H. Sargent and Fred H. Moffit (*U. S. Geol. Survey Bull. 797-E*, 1929; see also R. H. Sargent: Aerial Surveys in Southeastern Alaska, *The Military Engineer*, Vol. 20, 1928, pp. 189–195). An index map shows the area covered by the surveys—about 10,000 square miles and comprising the large islands of southeastern Alaska with the exception of Chichagof and Baranof. The first preliminary map sheet (Part of Ketchikan-Hyder Region, scale 1:250,000) constructed from the photographs also accompanies the report. This map shows drainage but not contours. The survey is now experimenting with an aerocartograph for determining relief directly from the photographs by stereographic principles (see "Mineral Industry of Alaska in 1927 and Administrative Report," by Philip S. Smith, *U. S. Geol. Survey Bull. 819-A*, 1929, p. 75).

Southeastern Alaska is well suited for an experimental air survey in that its extent of fiorded coast provides frequent landings for amphibian planes and that ground control is already provided by the charts of the U. S. Coast and Geodetic Survey. Photography was done with a tri-lens camera at a height of 10,000 feet. The flight routes, plotted beforehand, were laid across the islands east to west in order to obtain control at both ends. Weather played a predominant part in the accomplishment of the work. Only about 15 out of 90 days proved favorable for the purpose in hand, though a careful series of upper and lower air observations and the coöperation of 22 weather stations in southeastern Alaska enabled full opportunity to be taken of suitable conditions. One of the more immediate results of the survey was the plotting of forest distributions and of water power sites and the subsequent leasing of several tracts for lumbering purposes. A second aerial expedition went into the region this summer (1929.)

The "Geology of Hyder and Vicinity . . ." by A. F. Buddington (*U. S. Geol. Survey Bull. 807*, 1929) illustrates the type of detailed study made in a region where prospecting is active. Hyder, at the head of Portland Canal near the International Boundary, has been the scene of considerable prospecting since the great success of the Premier silver and gold mine on the Canadian side.

East and north of Fort Yukon lies a large area unmapped, save for the Canning River district explored by E. de K. Leffingwell, until J. B. Mertie started exploration of the Sheenjek tributary of the Porcupine River in 1926 (*U. S. Geol. Survey Bull. 797-C*, 1928). Subsequently work was carried on between the Sheenjek and the East Fork of the Chandalar, and in 1928 the survey was shifted to the territory between the Yukon and Tanana rivers.

In "Surveys in Northwestern Alaska in 1926" Philip S. Smith (*U. S. Geol. Survey Bull. 797-D*, 1929) describes the continuation of the work done in that region which

has been carried on successively since 1923 when the Naval Petroleum Reserve No. 4, lying between Point Barrow and Brooks Range, was created. The primary aim of reconnaissance here was the determination of oil resources. No indications of large oil deposits have been discovered as yet; and in view of the isolation of the area and the absence of timber, food, equipment, and labor any early development of the region seems unlikely. Surveys for oil have also been carried out in the Aniakchak district of the Alaska Peninsula. The rocks exposed do not encourage a hope for any considerable supply of oil, nor does drilling seem warranted (R. S. Knappen: Geology and Mineral Resources of the Aniakchak District, Alaska, *U. S. Geol. Survey Bull. 797-F*, 1929).

Difficult of access and avoided by trappers and prospectors, the country between the Alaska Range and Cook Inlet remained one of the largest unexplored areas in Alaska until S. R. Capps undertook his present series of expeditions. In 1926 the Skwentna was topographically and geologically mapped (*U. S. Geol. Survey Bull. 797-B*, 1929). In 1927 Capps carried a survey to the vicinity of Mt. Spurr, discovering lakes, glaciers, and mountains, including an active volcano. The work of 1928 was greatly expedited by the use of airplanes, which transported about half the party to the scene of action in a few hours whereas the pack train occupied weeks in arriving at its destination.

The Need for a Sound Land Policy in the United States. "Will our land area in the United States meet the demands of our future population?" "How are we to determine the best use of our land resources?" An attempt to answer these two questions is made in a little book entitled "What About the Year 2000?" recently published by the Joint Committee on Bases of Sound Land Policy. This committee, organized in 1927 by the Federated Societies on Planning and Parks, has "brought together specialists in agriculture, forestry, physical sciences, engineering, city planning, parks, and land economics," with a view to studying the "interrelations existing between the various land uses" and to paving the way toward the formulation and execution of sound policies and programs.

The rate of increase of our population is slowing down. Recent estimates by Professors Pearl and Reed of Johns Hopkins University and by Professor Whelpton of the Scripps Foundation for Population Research in Miami University indicate that the country will not have more than 200,000,000 inhabitants in the year 2000. "Perhaps the population will never greatly exceed this number, and probably will fall 10,000,000 or 15,000,000 below it. If we read aright the forces which determine the distribution of the population, most of these additional millions will live in urban territory. . . . " It is estimated that without any lowering in our standard of living and without any increase in the acreage devoted to agriculture our farm lands could support 180,000,000 people. They could support a very much larger number if the 608,000,000 acres of potential crop land not harvested in 1919 were utilized. Therefore, "considering everything, it appears unnecessary to worry about any long-time food scarcity in this country."

Indeed, at the moment the contrary is the case. "The present agricultural crisis seems to be due mainly to overproduction caused by cultivation of more land than is necessary under modern agricultural technique, for the present market demands." Although there are doubtless local areas where additional land might profitably be put to specialized agricultural uses, students of rural land utilization are mainly interested in the submarginal areas that ought, perhaps, never to have been farmed in the beginning. Where are these areas? Shall they be withdrawn from agriculture and allowed to revert to forest? How shall they be taxed? What shall be done with their inhabitants? Shall township and county governments which include a large amount of submarginal land under their jurisdiction be consolidated into larger units? When such questions can be definitely answered in regard to specific

regions and answered on the basis of sound policy that takes into consideration the best interests of region, state, and nation, we shall have advanced far toward the solution of one of the most pressing problems in the field of land planning. (See "Changes in Production and Consumption of Our Farm Products and the Trend in Population: Do We Need More Farm Land?" by O. E. Baker, *Annals Amer. Acad. of Polit. and Soc. Sci.*, Vol. 142, 1929, pp. 97–146.)

As our population increases and our economic system becomes more complex, the question of land utilization grows constantly more urgent and more difficult. "Demands for habitation, commerce, industry, farms, grazing, forests, mineral deposits, parks, highways, scenic drives, railway routes, inland navigation ways, power reservoirs, storage sites for metropolitan water supplies and irrigation of dry farming lands, and countless other uses, frequently fall upon identical or overlapping areas." The reconciliation and adjustment of these various demands and the promotion of harmonious development instead of a chaos of conflicting interests is the task of the land planner. This task demands a fundamental groundwork of facts that can be gleaned only through detailed coöperative local and regional surveys.

Problems of the American Town and Village. At the University of Minnesota there was held on June 24–28, 1929, a conference on the problems of towns and small cities. Of especial interest to geographers was the discussion on types of towns and their trends. Eight types may be recognized:

1. The village which is strictly a commercial service station for a rural community. This "cross roads" type has rather generally lost population, and many of the smaller villages, especially those not on a railroad or a main trunk highway are apparently likely to continue to decline. It is believed that many of them will practically disappear, because with automobiles and good roads an increasing percentage of the former patrons go to a larger town to make purchases and sales.

2. If these rural service stations have the advantage of railroad service or if, because of poor roads and considerable distance, it is not convenient for the farmer to go to larger towns, these small towns may continue to serve their locality but with little prospect of growth.

3. County seats. Most county seats are growing, at least slowly, as, now that automobiles are numerous, county seats serve a larger and larger area and have come to be the commercial as well as the political center of their county.

4. Most college towns are growing, with the increased popular demand for higher education. Most college towns are also county seats.

5. The towns which serve as service stations for the extractive industries, lumbering, mining, oil wells, fishing, are mostly declining—with the depletion of the source of wealth or because of increased competition of other areas. Many such towns have almost disappeared. In newly developed regions, however, such towns are growing, sometimes very rapidly.

6. Resort towns. With the great increase in the vacationing habit, associated with the increased use of the automobile, most resort towns are growing, and many villages are being benefited economically by the tourists.

7. An increasingly important class of towns is the residential suburbs of cities. These have increased greatly in number during the last quarter century with the improvement of transportation facilities. This type of town is experiencing a rapid and substantial growth.

8. Another distinct class of town is the small manufacturing community. Such towns arise in three ways: a large industry may establish decentralized units and build new towns for the purpose; the industry of the town may be the processing of the crops of the surrounding territory, for example, pea, corn, tomato canneries. Similarly, meat-packing plants are established to process products locally produced. A third sort of manufacturing town develops around the nucleus of some light in-

dustry or the manufacture of some specialty for which transportation costs are of minor importance. Some of these manufacturing plants are of local origin; but an increasing number are branches of factories or are factories that have moved from large cities to smaller towns.

During recent years considerable decentralization of manufacturing has occurred, and certain types of industries have increased more in towns and small cities than in large cities. For example, between the censuses of 1920 and 1924 (general and manufacturing) there was actually a decline in the number of workers engaged in industry in the cities of over 10,000 population, but there was a gain in the number in cities of less than 10,000. This is partly because the industries of the smaller cities are largely those employing much labor, while in the large cities labor-saving devices are increasingly used. The town and small city are favored over the large city also by the movement toward the integration of industry. Increasing recognition of the importance of favorable environment for employees is working in the same direction.

Specialization in manufacturing or other activity has occurred in some towns and small cities, and might advantageously be achieved elsewhere. Newton, Ia., is "the washing machine center" of the world, with four factories, one of which does a huge business. Connersville, Ind., manufactures most of the world's rotary pumps; and Alexandria, Ind., much of the mineral wool.

Although, of course, most towns must remain of negligible importance industrially, they can be kept on an economically sound basis if there is wise planning and a reasonable amount of coöperation. Statistical studies have disclosed what kinds of service institutions (stores, banks, professional men, etc.) and how many of each kind can be profitably maintained in towns of various sizes and types. Much good has already come to some towns by the dissemination of this sort of information, and by the effective pointing out of the benefit of coöperation, so that somewhere in each area the more urgent needs of the people can be supplied. The development of chain stores is helping many towns and small cities by providing a wide choice of standard merchandise at prices comparable to those found in the large cities.

An interesting phase of the conference dealt with the social value of American towns. Study of questionnaires filled out by 19,000 persons listed in "Who's Who in America," and by 9000 leading business men, and a study of biographical data concerning various other types of American leaders disclosed that in proportion to population the towns contributed several times as many leaders of almost all sorts as did the rural districts, and considerably more than did the large city. This may be due to superior advantages present for the development of leadership, for instance, towns affording closer social contacts than do either the farm or the large city. The town is also more convenient for experimentation in business and professional activity and individual leaders (teachers, preachers, business men) have more influence than all but the very exceptional leaders in the large city. More leaders were born in college towns and county seats than in other towns in proportion to population (except residential suburbs of large cities).

Another possible explanation of the superiority of towns in yielding leaders is that biologic selection has occurred. In the drift from country to city the first step is often the town. If a considerable share of the more alert people leave the farm for the town where their talents can be better employed and where their children will have better opportunity for an education, then, of course, the town should yield more leaders than the country if leadership depends largely on inherited ability. The large cities attract not only the more capable people from the country but also many of the less capable, as well as many manual workers from foreign lands.

Good descriptions of American towns and small cities are to be desired. Such descriptions are available for a number of large American cities; but the smaller urban communities have received only incidental consideration from most American

geographers. An exception is Robert S. Platt's "A Detail of Regional Geography: Ellison Bay Community as an Industrial Organism" (*Annals Assn. of Amer. Geogrs.*, Vol. 18, 1928, pp. 81–126). On the other hand we have some excellent town studies by sociologists, for instance N. L. Sims's "A Hoosier Village," (1912); J. F. Steiner's "American Communities in Action" (1925), and "Middletown" by R. S. Lynd and H. M. Lynd (1929). Sims describes his home town of Angola in northeastern Indiana, showing the interplay of geographic and non-geographic factors from the foundation of the village in 1835 to 1912. Steiner's "American Communities in Action" describes twenty towns, representing types scattered over several states, mostly in the South. Although the descriptions are less full than that of Sims, they too are by persons intimately acquainted with the towns, as each is by a graduate student of Professor Steiner of his own home town.

"Middletown" is an analytical description of Muncie, Ind. Although there is little formal geographic description, the setting is well given, careful attention is given to the effects of the discovery of natural gas and oil, to the improvement of transportation facilities, and to the development of other urban centers. Also attention is given to the local conditions within the small city which have led to contrasts in the types of residents and residences. This study of Muncie resembles Sims's "A Hoosier Village" in being a scholarly sociological study but differs from it in various significant ways. One is that Dr. Lynd, his wife, and other trained assistants went to Muncie as strangers and spent somewhat over a year in making a formal investigation which was financed by the Institute of Social and Religious Research of New York. The Lynds did not attempt to study conditions earlier than about 1890, while Sims traced the development of his village from its very inception. As Muncie is now much larger than Angola, its life is much more complex and social relations are much more predominant.

The Institute which financed the study of Muncie has contributed several valuable studies of American villages (population 250–2500). C. L. Fry has published five detailed statistical analyses of 177 scattered villages based on the returns of the 1920 census. In his "American Villagers" (1926) he sums up the findings of these analyses and other studies and presents some interesting conclusions, one of which is that one-eighth of the American population reside in villages and that the percentage is increasing. The 140 agricultural villages of the 177 just mentioned receive detailed attention in "American Agricultural Villages" by Brunner, Hughes, and Patten (1927). In Brunner's "Village Communities" (1927) the director presents a good summary of the institute's studies of villages.

The relationship of the village and the rural community, and various other problems of villages are well described in H. P. Douglass: "The Little Town" (1919). His book "The Urban Trend" (1925) is also of value. "Urban-Rural Relations," edited by Taylor and Frame (1928), and especially "Principles of Rural-Urban Sociology," by Sorokin and Zimmerman (1929), also merit consideration by those interested in American towns and small cities.

S. S. VISHER

The History of the Trans-Mississippi West. "The History of the Trans-Mississippi West" was the subject of a conference held from June 18 to 21 inclusive at the University of Colorado. The program, consisting of round table discussions together with lectures, touched upon all significant phases of western economic and social history and was full of geographic interest.

A number of papers were designed to fill gaps in order to add strength to the present store of factual information about the West. Such was the paper by Colin B. Goodykoontz on "Home Missions and Education," which supported Turner's early generalization that the East attempted to regulate the frontier through educational and religious activity. The papers by LeRoy R. Hafen, "Handcart Migration

Across the Plains"; John Carl Parrish, "By Sea to California"; and Louis Pelzer, "Trails of the Trans-Mississippi Cattle Frontier," constituted a series on methods of western travel. In "The Great Plains and the Industrial Revolution," Walter Prescott Webb pictured the semiarid country largely defying settlement until, aided by the Colt revolver, barbed wire for fencing, drills, windmills, and farm machinery, the American pioneer was able to develop a new technique in a new environment.

Other papers put forth new interpretations of old tenets. Herbert E. Bolton, in "Defensive Spanish Expansion and the Significance of the Borderlands," maintained the thesis that, contrary to prevailing opinion, Spanish colonization was notably successful; the peninsulas of Spanish control north of the Rio Grande later to be relinquished being considered chiefly the tenuous military and religious outposts of a vast Spanish domain to the South. "The West in Foreign Relations," by Eugene C. Barker, dealt with the boundary controversies growing out of the Louisiana Purchase and the methods and motives of the United States in the acquisition of California and the Southwest and proved to be a refreshing treatment of what might seem to be a threadbare theme.

Not a few papers raised new problems and discussed possible lines of further investigation, and in many of these projects the geographer's aid is implied. In his "Finance and the Frontier," Frederic L. Paxson suggests that groups of frontier people may be studied with greater ease than people in older societies and presents an impressive list of problems in frontier finance which should be studied in this connection. Joseph C. Schafer considered the problem of the regional rural survey with which type of study he has been so largely successful in Wisconsin. He suggests that in the absence of other less dependable documentary matter the Western historian must seek the Federal Land Survey, the Soil Survey, and the census schedules if he is to lay a solid foundation for the history of settlement in given communities.

A session avowedly devoted to geographic aspects of Western history was led by Carl Sauer. He outlined the field of historical geography as being chiefly concerned with the series of cultural forms by which man has given a succession of imprints to an area, or "the succession of cultural landscapes and their explanation." The American Indian is thus regarded as the original pioneer. To the white settler, who in part at least appropriated the trails and village sites of the Indian, the all-important question was the balance of resources which made possible his self-sufficiency, especially the vegetation cover and soil fertility. To study the frontier or plurality of frontiers formed in the westward movement, the reconstruction of the preëxistent vegetation is a necessary first step, because this factor was of greatest moment to the pioneer and largely determined the character of the frontier.

RALPH H. BROWN

The Virgin Islands of the United States. The economic future of the Virgin Islands of the United States has become a real problem. There is a continual unfavorable balance of trade; imports in 1927 amounted to $2,501,000 while the value of exports only reached $1,144,000. Shipping is attracted to these islands by their strategic position midway between Key West and the Panama Canal and by the excellent harbor of St. Thomas, which is largely dependent on bunkering, repairs, and trans-shipments.

Sugar is the chief product of the Virgin Islands. Although the advantages of the United States tariff make it a profitable crop, the mountainous character of St. Thomas and St. John islands are unfavorable, and the cultivation is confined to the fertile plains of St. Croix. Unfortunately, the crop here is limited by the distinctly variable rainfall, and there is small hope of increasing the sugar acreage through irrigation, for the geological formation of the island is unfavorable (R. S. Tucker: Economic Conditions of the Virgin Islands, *69th Congr. 1st Sess., Senate Doc. No. 41*, Washington, 1926).

Cotton, formerly of considerable significance, has disappeared as a cash crop on account of the ravages of the boll weevil. Raising cattle for the Porto Rico market has become an important activity particularly on the hilly islands of St. Thomas and St. John. Manufacture of bay rum is the only industrial activity—the finished product amounts to about five per cent of the total exports. There is a ready market in the United States, and exports are increasing; but the industry is dependent on Porto Rico for most of the raw constituents.

An adequate labor supply is one of the economic problems of the island. For many years population has been declining. An estimate places decline from the time of the first census, 1823, to 1917 at nearly 40 per cent. In spite of efforts made since 1917, decrease has continued through emigration into the United States, which is now practically unrestricted. Recently Porto Ricans have been imported to solve the labor shortage cause by emigration and the low efficiency of the natives.

In the face of such conditions the economic future of the islands would seem to lie along new paths. A report by the Governor ("The Virgin Islands of the United States; A General Report by the Governor," Navy Dept., Washington, 1928) offers two solutions. The first of these is a diversification of agriculture by the introduction of market gardening. Onions, egg plant, peppers, and tomatoes have been sent to the New York market with some success (see "Report of the Virgin Islands Agricultural Experiment Station, 1927," [*Publ.*] *Virgin Islands Agric. Exper. Sta., St. Croix*, U. S. Dept. of Agric., Washington, 1928). Although in its early stages and needing careful management, there seems to be a real future for this industry. The second solution, development of the tourist industry, has hardly begun—accommodations being almost completely lacking. The climate is well suited to the requirements of a winter resort, and the islands have a picturesque background both natural and historical (see M. E. Brooke: Casual Glimpses of St. Thomas, the Island of Blackbeard and Bay Rum, *Bull. Geogr. Soc. of Philadelphia*, Vol. 27, 1929, pp. 43–53). Three regular lines of passenger steamers now touch at the islands, and an increasing number of Carribbean tours call at the harbor of St. Thomas (see W. L. Thompson: The Virgin Islands of the United States, *U. S. Naval Inst. Proc.*, Vol. 55, 1929, pp. 289–295).

SOUTH AMERICA

Urban Development in South America. Historical forces of widely divergent origin have given the larger cities of South America their outward form and inner character. The early town, with central plaza and straight, narrow streets laid out in rectangular pattern, was often modeled upon the town plans of Spain and Portugal, and these in turn owed much to the Roman *castra*. The low-roofed dwelling surrounding a court was also borrowed from Mediterranean lands. From the Europe of the mid-nineteenth century, particularly from Paris, came the broad, tree-lined boulevard and the ornately decorated neo-Renaissance architecture of public buildings. At the present time the North American skyscraper is making its appearance.

The last betokens a mighty change now in progress throughout Hispanic America. "The typically national, traditional city" is fast giving way to the international metropolis. The population of Rio de Janeiro and of Buenos Aires in 1925 had reached 1,500,000 and 2,000,000 respectively. Increase in the population of the larger cities—especially of the capitals—has been relatively more rapid than that of each nation as a whole. In Uruguay 18 per cent of the population lived in Montevideo in 1875, and 28 per cent in 1925; in the Argentine the corresponding increase in the percentage of the total population living in the capital was from 10 to 20; in Chile, from 8 to 13; in Paraguay, from 6 to 11; in Brazil, Bolivia, Peru, and Venezuela, from 3 to 4; and in Colombia from 1 to 2. In Ecuador alone was there

a decrease: 9 per cent of the Ecuadorians lived in Quito in 1875 and only 5 per cent in 1925. The recent change in urban character, however, is not a mere question of absolute or relative size. South America is becoming industrialized, and industrialization has meant not only the growth of manufactures but a flood of immigration and foreign control of nearly all economic functions except those of agriculture. Most of the recent immigrants are city-bred. On arrival they take up their residence in the metropolitan centers or else float back to them after short sojourns in the provincial towns. Foreign labor, foreign capital, and foreign industrial management are thus producing not only material growth but a more international character in the larger cities of South America.

These urban trends are clearly described in a recent article by Dr. Wahrhold Drascher in *Mitteilungen der Geographischen Gesellschaft in Hamburg*, Vol. 39, 1928, pp. 64–86.

The Control of Yellow Fever in Brazil. It is reported that Christopher Columbus discovered yellow fever when he discovered the new continent. In 1701 it was introduced to Europe by the Spaniards, and its appearance half a century later on the west coast of Africa may have been a result of the North American slave trade. Though climatic conditions are favorable, yellow fever has never become established in Asia. (M. Marchoux: La fièvre jaune, *Congo*, Vol. 1, 1928, pp. 348–365.) The disease is transmitted through the mosquito *Aedes aegypti* (or *Stegomyia fasciata*), and is potentially endemic only where the temperature remains above 20° C. throughout the year. Where the temperature is above 20° for a part of the year it may be epidemic. In 1900 it was endemic along all the tropical coasts of the Americas and along the west coast of Africa.

Aedes aegypti is a domestic mosquito, thriving only near human habitation. It was hoped that, by exterminating the mosquito near centers of population, it would automatically die out in the rural districts. In 1918 the Rockefeller Foundation in coöperation with the national governments began a campaign against yellow fever in the western hemisphere. A similar campaign was initiated at Lagos in Nigeria in 1925. For the year 1925 but three cases of yellow fever were reported in the Americas by the Rockefeller Foundation (G. E. Vincent: The Rockefeller Foundation: A Review for 1925, pp. 13–17), and it was hoped that the disease was completely under control. In 1926 a revolt broke out in northern Brazil, and fleeing rebels were pursued by Brazilian troops into the interior of the country where the fever was still endemic. The soldiers introduced the fever to the coast cities; and mild, undetected cases among those who returned to Rio de Janeiro were probably responsible for the epidemic of 1928 in the capital. A recent number of the Archivos de Hygiene of the Brazilian Department of Public Safety (Vol. 3, No. 1, 1929) attributes the development of this epidemic to a relaxing of the campaign against mosquitoes, combined with unusually warm temperatures during the first quarter of 1928. Investigations of the Rockefeller Foundation (G. E. Vincent: The Rockefeller Foundation: A Review for 1928, pp. 26–34) indicate that, in Africa at least, yellow fever may be transmitted by agents other than *Aedes aegypti* and that it may remain active in the interior of the countries even when under control in centers of population. This enlarges the field of search for the cause of yellow fever and postpones to a future date its complete control.

EUROPE

Swiss Colonization in Depopulated France. The worst spot in France for childlessness is Armagnac, the heart of Gascony. About halfway between the Bay of Biscay and the Mediterranean the famous detrital cone of Lannemezan gives the Adour and the southern tributaries of the Garonne their singular, divergent, fanlike

pattern. They are deep sunk in the surface of the cone, on the crests of whose interfluves are perched the villages of Gascony. This is d'Artagnan's country.

The two departments Gers and Lot-et-Garonne, together making up Armagnac, have 141 and 147 births a year to ten thousand inhabitants. With mortality in France always above 173, so low a birth rate must depopulate the countryside. This depopulation is made very real in a study by Hans Bernhard, "Landbauzonen, ländliche Entvölkerung und landwirtschaftliche Einwanderung in Frankreich, mit besonderer Berücksichtigung der schweizerischen Ansiedlung in Südwestfrankreich" (*Schriften der Schweizerischen Vereinigung für Innenkolonisation und industrielle Landwirtschaft*, No. 35, Zurich, 1927).

The climate is admirable, the region fertile. The prunes of Agens and the brandy of Armagnac are widely appreciated. Table grapes, early vegetables, and tobacco provide cash crops, and the country is the best in France for grain and wines. To its excess of good things has been ascribed a condition which seems to inspire the inhabitants to the least possible effort. This notion of Gascon laziness Bernhard dispels most effectively in his picture of daily life on a modern Gascon farm. "The peasant family of southwestern France works hard, and the wife does almost more than she can endure."

It happens that an American author, Jay William Hudson, has been drawing charming pictures of this same country about Gers. "A vast rolling expanse of valley and hill, valley and hill, great waves of countless hills one after another, breaking into the spray of trees on the summits; and on every summit an ancient village, with the church tower rising above the little clustered houses, the good gray guardian of a long past and the symbol of a dream. There are the fields, many of them vineyards, sloping in every direction, and of every geometric pattern, bordered with hedges, dotted with white-walled houses, their red-tiled roofs mellowed brown by time; trees everywhere, none so conspicuous as the tall, upstanding poplars, following the devious ways of the little streams; everything green, green, green, except the winding, white roads, leading up hill and down hill and far away toward the lofty Pyrenees, just visible through the delicate, violet haze that floats along the southern edge of the world like a thin veil . . . its rolling hills all traced out into designs by the roads and hedges, it is like an undulating tapestry" (J. W. Hudson: Abbé Pierre, New York, 1928, p. 17).

In this charming landscape farms are abandoned in every direction, the buildings falling into ruin, and the fields growing up to weeds and furze. There has been death of childless couples, and there has been drift to the city as everywhere in France and in other countries. The cause of the low birth rate Bernhard finds in the prevalent ideal of the minimum family. Other things helped. In the seventies the Phylloxera came here. Nearly a million hectares have gone out of grapes since that time. Railroads are insufficient and give poor service. Many of the roads are impassable. It is not easy to get crops to a market. But mainly the people preferred not to have children.

Naturally the price of farms is very low. When the franc took its downward plunge in 1922, the Swiss peasant, who must pay $600 to $800 an acre for farms at home—buildings included, could get them here for $75 to $120, and one of his francs was worth four French ones. As this opportunity came at a time of industrial depression in Switzerland, when unemployment was increasing from 6000 in 1920 to 58,000 in 1921 and 67,000 in 1922, while in the United States the imposition of the quota cut down the increasing Swiss immigration from 8000 to 4000, it is not to be wondered at that Swiss with large families took up farms in Armagnac, buying them, renting for cash or on shares, and even took up farm work as hired families in that excellent market for farm labor, while looking for a chance to get a farm of their own.

Bernhard's volume is full of statistical data, a little confusing at times in their

abundance, giving a complete account of the population and agriculture of France. For the Swiss settlers in Armagnac he found little information available and spent three months on the ground in the spring of 1926. His results come from personal observations and direct questioning of as many settlers as possible. He was well received and has been able to draw a picture of an adventure in immigration that should be gratifying to both France and Switzerland.

MARK JEFFERSON

Glaciological Research in the Horung Massif, Norway. With several collaborators and assistants Professor Hans W. Ahlmann has carried out studies since 1918 on the physiography, meteorology, hydrography, etc. of the Horung Mountains (61½° N., 8° E.) near the head of the Sognefjorden in western Norway (H. W. Ahlmann, A. Tveten, J. Eythorsson, and E. Lindskog: Physio-geographical researches in the Horung Massif, Jotunheim, *Geogr. Annaler*, Vol. 5, 1923, pp. 51–58; Vol. 9, 1927, pp. 9–66; Vol. 10, 1928, pp. 1–66). The Horung Mountains attain altitudes of 2000 to 2400 meters and are deeply dissected into ridges and sharp peaks by ice-worn cirques and valleys. They carry several glaciers, which to a considerable degree are nourished by formation of hoarfrost during high winds from the sea.

His observations on this factor lead Dr. Ahlmann to suggest that as regards the maritime regions of northwestern Europe "the formation of hoarfrost possibly may have played a great part in glacier formation during the Ice Age" (H. W. Ahlmann: On the Formation of Hoarfrost and Its Relation to Glacial Growth, *Journ. of Geol.*, Vol. 37, 1929, pp. 275–280). The transformation of snow into firn and ice was found to consist mainly in sublimation. The increase of the summer precipitation for every 100 meters altitude is about 10 per cent of the precipitation at the base, while the average increase per 100 meters altitude on the Norwegian south coast is about 15 per cent, on the west coast about 13 per cent, and on the coast from Ålesund to Lofoten 17 per cent of the rainfall at sea level. The daily variations in the run-off of the glaciers were greatest in the beginning of August and smallest during the last days of autumn. They followed the variations of the air temperature fairly well. The greatest run-off was in July. The Styggedal glacier, which was in a state of equilibrium during the years of investigation (1923–1926), flowed at a somewhat greater rate in summer than in winter, though the rate of flow during the summer was variable.

ERNST ANTEVS

AFRICA

Progress in East African Meteorology. The establishment in January last of a Joint Meteorological Service for British East Africa is an event of significance in itself and in its implications (A. Walter: Note on the Inauguration of a Joint Meteorological Service for British East African Territories, *Memoirs No. 1*, Nairobi, 1929). The East Africa Commission's Report of 1925 (Cmd. 2387) made clear the need for "greater coöperation and understanding" between the several administrative units. The Committee on Closer Union of the Dependencies in Eastern and Central Africa (Cmd. 3234, 1929) has carried things a stage further with its definite recommendation of a "Central Authority" for administrative policies and for coördination of services of common interest. The political problem is truly difficult, as Mr. J. H. Oldham, a member of the Commission, emphasizes in a recent discussion of the Report (*Journ. Royal Inst. of Internatl. Affairs*, Vol. 8, 1929, pp. 227–259). It must be solved before the closer economic union that is desirable can become a reality. Meanwhile steps towards coördination can be taken in the field of scientific research; and in the new meteorological service lies an exceptional opportunity, for it is closely tied in with the projected air services. As the Commission states, "great possibilities for the future of communications as a help towards administrative union lie in the development of air routes."

The dependence of commercial aviation on organized meteorological services has already become a familiar state of affairs. Less has been heard of the correlative—the impetus given to theoretical meteorology. The East African region lying athwart the equator and having available stations ranging in altitude from sea level to over 10,000 feet is a zone of particular importance from the standpoint of the general circulation of the atmosphere. Also it offers interesting problems of its own. It is proposed to make a special study of the problems connected with the rise and fall of the lakes and the Nile flow, and of the "possible influences of forests on what appears to be a progressive desiccation of Africa."

The Service covers Kenya, Uganda, Zanzibar, Tanganyika, and Northern Rhodesia. Egypt and the Sudan also contribute funds to the support of the undertaking. Portuguese East Africa, Southern Rhodesia, and the Belgian Congo have promised coöperation; and Seychelles, Mauritius, and Madagascar are also expected to send telegraphic reports, so that a system of forecast and warning can be applied to the adjacent waters. Five stations of the first order are being set up: at Nairobi (central office); Port Bell, Uganda, where it is also proposed to establish a base for the Air Services; Tabora; Zanzibar; and Mazabuka, in the Kafue Basin of Northern Rhodesia. Some forty stations of the second order are projected. The creation of this service should go far towards removing the reproach on Africa's backwardness in meteorology to which Mr. Jan Hofmeyr alluded in his inaugural address to the British and South African Associations in Cape Town in July ("Africa and Science," *Nature*, No. 3117, Vol. 124, 1929, July 27, Suppl., pp. 135–145; esp. p. 140).

Diamond Deposits of Little Namaqualand. The discovery of a small diamond north of Port Nolloth in February, 1926, revived an interest in and attracted a flood of prospectors to the desert coast of Little Namaqualand. Within a year the fact was established that a vast diamond field extended from the mouth of the Orange to the south bank of the Groen River, a distance of over 200 miles (Percy A. Wagner and Hans Merensky: The Diamond Deposits on the Coast of Little Namaqualand, *Trans. Geol. Soc. of South Africa*, Vol. 31, 1929, pp. 1–41). The diamonds occur for the most part in marine shingle deposits of the coast terraces, concealed beneath a mantle of sand and other surface material. In this respect they are at a disadvantage as compared with the Southwest African field which benefits by the powerful action of the south-southwesterly winds. "Were wind velocities of the order of those experienced in South-West Africa prevalent in the part of the littoral under discussion, the Namaqualand diamond fields would be without doubt the most easily worked in the world as in that case the finer surface detritus would all have been blown away."

The richest workings are at Alexander Bay, a short distance south of the mouth of the Orange River. The stones here are unlike those of the Southwest African fields, and some of them, of great brilliance and purity, are unlike those found anywhere else in South Africa. What is the origin of the diamonds of these new fields? As in the case of the "Diamond Coast" north of the Orange River, three sources have been predicated—from the interior, either from Griqualand West or the Orange Free State, brought down by the Orange River, or from local primary sources brought down by local rivers, or from some submarine source.

The interior of South Africa is an extremely old land mass and has suffered an enormous amount of denudation. During past times of heavier rainfall tributaries of the Orange River previously drained much larger areas than they do today, and dry valleys like the Brak, which may contain water but once in a lifetime, carried swiftly flowing streams of considerable volume (W. A. Humphrey: The Changed Conditions of Namaqualand, *Trans. Royal Soc. of South Africa*, Vol. 14, 1927, pp. 219–224). In the interior diamonds occur in the pipes of extinct volcanoes. The area of diamond bearing pipes and the extent of denudation are enough to

account for the diamond deposits of the coast. This theory of the origin of the diamonds is supported by E. J. Dunn in "Diamonds in South Africa" (*Geol. Mag.*, Vol. 66, 1929, pp. 334–336). But the diamonds found near the mouths of the Kamma, Buffels, and Groen rivers are unlike each other and differ from those discovered near the mouth of the Orange River. The upper reaches of the Kamma and Buffels rivers have been prospected, but no diamonds have been found away from the coast.

Messrs. Wagner and Merensky maintain a conservative attitude towards this difficult problem. After pointing out pros and cons for the various theories, they conclude with the interesting comment: "All that can be said with certainty is that, except for those found in certain occurrences at the mouth of the Orange River, the diamonds of these remarkable Namaqualand deposits were cast up by the sea at a time when the coast stood considerably lower relatively to the sea than at present, and there was a warm northward current off it in place of the present cold Benguela current." As regards the prospects of the fields they are likewise cautious, but they observe that the good quality of the Namaqualand stones will do much to restore the prestige of the South African diamond industry which has been lowered recently by a large production of inferior stones from certain mines and from the enormous output of the Lichtenburg alluvial deposits in the Transvaal. The latter were discovered in 1926 and, as Dr. Wagner states in the volume of the Handbuch der Regionalen Geólogie on "The Union of South Africa" (Heidelberg, 1929), supported in April, 1927, a population of 50,000 Europeans and 90,000 natives.

ASIA

Archeological Air Photography in the Middle East. A thousand miles of country and five thousand years of human progress were spanned by Mr. O. G. S. Crawford in his recent trip to the Middle East (Air Photographs of the Middle East, *Geogr. Journ.*, Vol. 73, 1929, pp. 497–512). Mr. Crawford's pioneer work in archeological air photography is well known. Reference to his application of aerial survey as an aid in prehistoric geography of southern England has been made in the *Geographical Review* (Vol. 13, 1923, p. 616). Since then "Wessex from the Air" has appeared, written in collaboration with Mr. Alexander Keiller (Oxford, 1928). This is a collection of fifty striking aerial photographs of archeological sites within a thirty-mile radius of Stonehenge. The photographs are beautifully reproduced and accompanied by a descriptive text prefaced by a brief introduction on the history and bibliography of archeology from the air. Many archeological aerial photographs have also appeared in *Antiquity*, of which journal Mr. Crawford is editor.

Mr. Crawford's recent trip was undertaken to establish the basis for a permanent collection of archeological air photographs. How successfully his mission was filled is indicated by the fact that he brought back with him several thousand negatives taken by the British Air Forces in Egypt, Trans-Jordan, and 'Iraq. These have been deposited in the British Museum. Their value may be gauged by the examples illustrating his article. For special treatment three types of ancient town plans in 'Iraq were here singled out. The ruins of the Abbasid city of Samarra stretch for 20 miles along the Tigris. Hatra is a fine example of a Parthian site 75 miles northwest of Mosul. A mosaic of this site taken in "five minutes" helps to fill in the plan executed by Andrae in 1908 after weeks of work on the ground. Seleucia is a Macedonian site whose exact location has been in debate. "What is plainly the correct site was discovered and photographed by Squadron-Leader Insall, and it may well prove to be one of the classic achievements of aeroplane observation and photography." Passing briefly over the antiquities of the Syrian Desert and Trans-Jordan Mr. Crawford concludes with a notice of Masada overlooking the western shores of the Dead Sea and famous for its siege of 72 A. D. The siege works are well

preserved, and "every detail of internal plan is plainly recorded." (See also photographs accompanying Christopher Hawkes: The Roman Siege of Masada, *Antiquity*, Vol. 3, 1929, pp. 195–213.)

Mr. Crawford makes the important point that "air photography will eventually enable ancient sites to be classified chronologically from their external appearance"; and his last word is that "the future of exploration, and not only of archaeological exploration, is literally in the air."

Russian Expansion in Asia. In "Russian Imperialism in Asia: Its Origin, Evolution and Character" (*Slavonic Rev.*, Vol. 8, 1929, pp. 28–47), Prince A. Lobanov-Rostovsky gives an illustration of what Mackinder has termed the transparency of history to the underlying facts of geography. He draws a distinction between "natural growth" and imperialism, regarding the former as a spontaneous movement on the part of the people of the country, the latter as action dictated by the government. Russia, once her energies were directed eastward, moved smoothly over the vast "no man's land" of the Eurasian plain, the "Great Lowland" permitting a mobility almost equal to that of the sea. Natural expansion was stopped by the barrier of the Hindu Kush–Pamir–Tian Shan–Gobi–Khingans. Where Russia attempted to break across the barrier and penetrate the buffer states between herself and China, expansion took on imperialistic form, whether in search of an outlet to the free sea through Manchuria, or to tap the inner markets of Mongolia and Dzungaria (Chinese Turkestan or Sinkiang), or to divert revolutionary tendencies at home.

Between Russian expansion over the plain eastward in Siberia and southward in Central Asia there is, however, considerable dissimilarity. In "The Soviet Muslim Republics in Central Asia" (*Journ. Royal Inst. of Internatl. Affairs*, Vol. 7, 1928, pp. 241–255) Prince Lobanov-Rostovsky deals with present conditions in Central Asia. Russian conquest of that region dates only from the latter part of the past century. Turkestan may be looked on as an oversea colony, sand being substituted for water: "it takes over two days for the express to plough through the great desert of Kizil Kum which forms the gateway between Russia and Turkestan." Moreover, climatic conditions are exotic and, especially in the far south—the old Khanates of Khiva and Bukhara—the land is alien, fit rather for economic exploitation than for colonization. The three significant facts of Russian occupation in Turkestan are the comparatively small number of Russians—600,000 out of a total population of over 8,000,000, the hold secured by the railway system, and the value of the cotton production.

Before the war the cotton of Turkestan together with that of Transcaspia furnished the greater part of Russia's needs. As a result of the upheavals after the war, production has declined; but its revival is one of the major concerns of the Soviet government today. In 1924 the political organization of the country was entirely reformed, new Soviet Republics being created on an ethnographic basis. The strong control exercised by Moscow is economic as well as political. Among other economic provisions is one placing the cotton-growing industry under the direction of two limited companies with the majority of the shares subscribed by Moscow. On a similar basis limited companies have been formed for the correlative importation of wheat and for the silk and wine industries. Irrigation also has been placed under a special section of the Moscow Soviet of Labor and Defense.

Of great importance is the new Turkestan-Siberian railway, now under construction. When completed, the line will unite Tashkent and Novosibirsk via Semipalatinsk and the eastern end of Lake Balkash; 1931 is the date set for completion. It is expected that a wave of colonization will follow, coming not from the northwest in the traditional way but from the northeast, that is from Siberia. It is a mistake to assume that Siberia is very much underpopulated, says Prince Lobanov-

Rostovsky. The best land along and around the Trans-Siberian Railway is already occupied. "The new settler has either to turn north into the arctic waste or attempt to conquer the Taiga, the great virgin forest which in the power it opposes to the pioneer is comparable only to a tropical jungle." Pre-revolutionary figures leave no question as to the great expense of colonization in the steppe-forest belt as compared with the steppe and in the *taiga* as compared with the steppe forest (B. N. Zhdarov: Effectiveness and Costs of Inland Immigration, *North Asia: Journ. of Soc. Sci.*, No. 4, 1928 [in Russian]). Settlers will tend to follow the line of least resistance, and that will be to the rich steppes of Kazakistan south of Lake Balkash. In addition to agricultural resources the railway will open up an area of considerable mineral wealth. Statistical data on the railway and its tributary area are given in an article by A. U. Rudzyt, "The Turkestan-Siberian Railway" (*ibid.*, No. 2, 1928, pp. 5–34, of which an abstract appears in *Soc. Sci. Abstracts*, Vol. 1, 1929, p. 392).

Agricultural Afghanistan. "Afghanistan with the adjacent countries, especially the districts of North-Western India is one of the most important primary world agricultural centers. With regard to the diversity of club wheats, as well as of the whole group of soft wheats in general, Afghanistan occupies the first place among all countries of our planet." Such are the conclusions of Professor Vavilov, who in 1924 made an extensive study of this one of the five principal world centers of distribution of cultivated plants as established by him in his "Studies on the Origin of Cultivated Plants" (Leningrad, 1926; reviewed in *Geogr. Rev.*, Vol. 17, 1927, pp. 693–695). His expedition, traveling about 6000 kilometers, covered the whole of agricultural Afghanistan including the isolated region of Kafiristan, where the inhabitants, fearing the hostility of their neighbors, cultivate their crops in practically inaccessible heights. In addition to proving Afghanistan the center where the forms of soft wheat have originated, the expedition found a weed rye and traced the whole process of the introduction of rye into civilization (see N. I. Vavilov and D. D. Bukinich: Agricultural Afghanistan; *Bull. of Applied Botany, of Genetics and Plant-Breeding, Suppl. 33*, Leningrad, 1929. In Russian with English summary).

These genetic studies, however, represent only a part of the comprehensive program of the expedition. Crops and systems of native agriculture were studied with, as ulterior object, the furthering of economic relations between Afghanistan and the U. S. S. R. In particular, attention was paid to irrigation and cotton growing. It is suggested that "the construction of the Turkestan-Siberia railway will supply Afghanistan with cheap wheat from Siberia and thus free the acreage now under the wheat for the cultivation of a more precious crop."

In Afghanistan primitive forms of agriculture exist side by side with an intensified practice which employs fertilizers, crop rotation, and irrigation. The former is instanced in the high mountain valleys of Bamina some 200 kilometers west of Kabul; the latter in the valley of Hari-Rud near Herat, where the expedition counted no less than one hundred different crops under cultivation. Of the cultivated area of Afghanistan (about two per cent of the total) at least half (500,000 hectares) is irrigated. At present the irrigated area of Northern Afghanistan is about twice as large as that of Southern Afghanistan, where, however, there is about three times as much potential agricultural land as in Northern Afghanistan.

Professor Vavilov also gives a general survey of the physical conditions of the country, dividing it into six climatic zones. He distinguishes the following nine "agricultural or geographical landscapes": (1) Undulating steppes of the foothills of Northern Afghanistan, (2) the valley of Hari-Rud, (3) the southern deserts of Afghanistan, (4) the Oasis of Kandahar, (5) mountain valleys from 1400 to 2600 meters, (6) the lowlands of Jalabad, (7) high mountain landscape above 2600 meters, (8) landscape of Kafiristan (forest zone), (9) thin stand of juniper and pistachio trees.

The Lumber Industry of Southern Manchuria. Bean and grain fields, coal and iron mines do not tell the tale of Manchuria's riches: there are her forested mountains. According to the latest estimate forests cover 45,000,000 acres, or one-fifth of the total area of the Three Eastern Provinces, a proportion similar to that for the United States. The major forest regions are found in the Great and Little Khingan ranges in the north (Heilungkiang), the Ch'ang Pai Shan in the center (Kirin), and the Yalu River basin in the south (Fengtien). These areas are estimated to contain about 116 billion cubic feet of lumber, and some 26 billion feet may be added for other little-known districts in the three provinces ("Lumber Industry on the Yalu River," *Chinese Econ. Journ.*, Vol. 4, 1929, pp. 522–533). The bulk of the lumber from eastern Manchuria is transported on the Sungari and Yalu rivers, thus dividing the country into northern and southern zones with Changchun, the joint terminal of the South Manchurian and the Chinese Eastern railways, as a common point.

Exploitation of the Manchurian forests on a large scale commenced with the organization of a Russian company to work the timber lands on both banks of the Yalu at the beginning of the present century. Incidentally it was one of the contributing causes to the Russo-Japanese War. At the conclusion of the war the Japanese government took over the regulation of the lumber trade on the Yalu. Forestry on the Korean side became a public enterprise of the office of the Governor-General of Chosen; exploitation of the Manchurian side passed under the control of a Japanese-Chinese concern. Between the two régimes there is now a marked difference. On the Korean side the industry is carefully regulated; on the Manchurian side "no system of afforestation and deforestation has yet been worked out. . . . Deforested areas are now lying waste, and if no forestry law is enacted the rich timber territory may some day become entirely non-productive." Lumbering in the Manchurian-Yalu region is a mixture of old and modern methods. For getting out the logs, for instance, in a few places light railways have been constructed; in other places they are dragged out by cattle. From the river banks the logs are rafted downstream to the headquarters of the company at Antung, between May and December as many as 20,000 of these "strikingly fashioned" rafts coming down the Yalu (compare Adachi Kinnosuke: Manchuria: A Survey, New York, 1925). Thence distribution is made to the cities of Korea, Fengtien, the Gulf of Pechili, and as far afield as Shanghai, Hankow, and the Yangtze cities. Recently, however, there has been a decline in the timber trade of the Yalu, largely through the concurrence of cheaper timber from the great forests of northern Manchuria.

AUSTRALASIA AND OCEANIA

The Morioris of the Chatham Islands. Although there were believed to have been about 1600 Morioris inhabiting the Chatham Islands when these islands were discovered by Broughton in 1790, H. D. Skinner who visited the group in 1920 found only two. (The Morioris of Chatham Islands, *Memoirs Bishop Museum*, Honolulu, Vol. 9, No. 1, 1923). He ascribed this virtual extermination of a race to a number of contributing causes: the introduction of European epidemic diseases, the increasing scarcity of whales and seals from which food and clothing were obtained, and the Maori invasion of 1835 when the Morioris were virtually enslaved. At present, the 450 odd people of a dozen mixed nationalities who inhabit the islands make a livelihood by raising sheep and cattle. The northern half of Pitt Island is cleared of bush and comprises one cattle ranch.

The origin of the Morioris is obscure. H. D. Skinner continued his studies of the problem as a member of the Otago Institute Expedition of 1924 and concluded that they are a Maori offshoot which probably migrated from New Zealand before their textile technique was developed, at about 1350 (*Memoirs Bishop Museum*,

Vol. 9, No. 5, 1928). New Zealand, which lacked certain elements of Polynesian culture, thus acted as a stepping stone for these early Polynesian migrants who found the Chatham Islands lacking in the major elements of Polynesian food supply —breadfruit, coconuts, and the sweet potato. Consequently, the Moriori hunted the seal and whale until the destruction of these animals by Europeans contributed to their extermination.

To this day the Chatham Islands, which became part of the Dominion of New Zealand in 1842, are an isolated and little-known group. The islands, which lie some 536 miles east of Lyttleton, comprise Chatham Island (Rekohua) and a group of small islands to the southeast, of which Pitt Island is the largest. Information on the physical features of the Chatham Islands has been summarized by R. S. Allan (*Trans. and Proc. New Zealand Inst.*, Vol. 59, 1928, pp. 824–839). Te Whanga Lagoon in the central part of Chatham Island covers 46,000 acres of the total extent of 222,000 acres. To the north of Te Whanga Lagoon are two connected peninsulas with low-lying mature slopes, the western one showing signs of volcanic activity. The southern part of the island, which rises to nearly 1000 feet along the south coast, is a compact highly dissected remnant of a plateau area. The original bush covering of the islands is extremely dense and contains no large timber. A superficial covering of peat overlies the whole island.

POLAR REGIONS

Nobile's Flights in the Arctic on the Airship "Italia," May, 1928. The unfortunate disaster to the airship *Italia* at the end of the Nobile Arctic flights, May, 1928, the loss of part of its crew, and the rescue of the survivors were matters of such dramatic interest tinged with controversy that they have obscured the real achievements of those flights. It is only now when a number of authentic narratives have appeared, especially an article on the geographical results of the expedition by General Nobile himself ("Die geographischen Ergebnisse der Polarexpeditionen der 'Norge' und der 'Italia,' *Petermanns Mitt.*, Vol. 75, 1929, pp. 189–192) that it is possible to present a connected picture of the flights. This has been much facilitated by General Nobile's courtesy in sending to the American Geographical Society two maps showing the route of the north pole flight and the flight to Northern Land and the areas seen on those flights.

After an initial flight from Kings Bay on May 11, on which it was not possible to proceed beyond North Cape, the *Italia* left on May 15 on the flight to Northern Land. The outward route led eastward along the northern border of the Spitsbergen and Franz Josef Land archipelagoes to a maximum easting in latitude 79° 16′ N. and longitude 91° 40′ E. The return route led thence southwest to the northern end of Novaya Zemlya and thence west-northwest back to Spitsbergen, where Kings Bay was reached on May 18. Between Spitsbergen and Franz Josef Land the reputed position of Gillis Land in 81° 40′ N. and 37° 5′ E. was flown over and no land seen in this vicinity. Parenthetically it may be observed that the land of this name which Captain Gillis reported to have seen in 1707 is probably identical with Gillis Island (also spelled Gilles and Giles) which rises from the submarine ridge connecting the two archipelagoes and whose true position in 80° 3′ N. and 31° 30′ E. was determined by Commander F. A. Worsley in 1925. Even current hydrographic charts, however, showed Gillis Land in the position in which it was sought by Nobile.

Between Franz Josef Land and Northern Land in about latitude 80° and longitude 84° 30′ E. an area of open water extending northwest and southeast, varying from 10 to 40 kilometers in width, was encountered. As the wind was from the north and northeast it was inferred that this open water might indicate the presence of land in whose lee it would then be lying. This locality lies to the east of the drift of the *St. Anna* in 1913–1914 and would agree well with Wiese's deduction of the probability

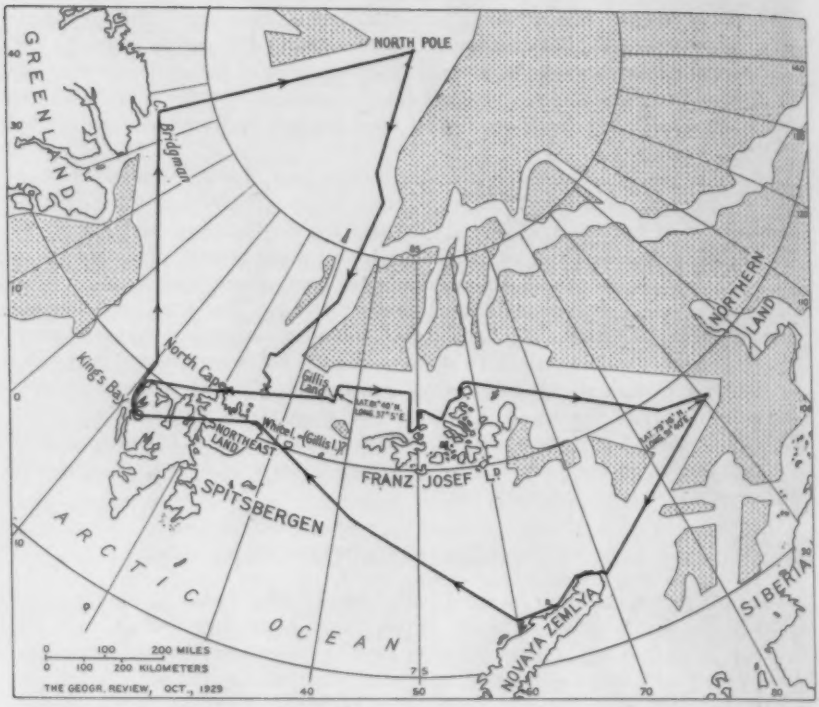

FIG. 1—Map showing routes of the *Italia* on the Northern Land and north pole flights, May, 1928. Scale 1:20,000,000.

Areas unexplored or not seen are shown in stipple. The routes of the *Italia* and the estimated areas seen along her path are based on manuscript maps sent to the American Geographical Society by General Nobile.

of land in this vicinity on the basis of that drift (*Ergänzungsheft No. 188 zu Petermanns Mitt.*, 1925, pp. 57–58 and Pl. 2, Fig. 4). The flight continued thence for a little less than 100 miles to the most easterly point, but weather conditions unfortunately made it impossible to establish the desired relationship to the known eastern coast of Northern Land. The problem of the western limit of Northern Land therefore still remains unsolved, although Nobile himself believes it probable that the area is an archipelago of which the conjectured land to the windward of the open water area may have been a western member. On this flight Nobile estimates that about 48,000 square kilometers of heretofore unseen territory were seen. These are indicated on the accompanying map.

The flight to the pole took place on May 23, the pole being reached between midnight and 1 a. m., May 24. As it was unfortunately not possible to carry out the original intention of landing there to take a sounding and make other observations, we are still uninformed as to the exact depth of the deep basin of the Arctic Sea at this point and are still dependent on Peary's no-bottom sounding of 2743 meters. The main geographical result of this flight was the crossing, on the leg between Spitsbergen and Cape Bridgman, of the unexplored area off the northeastern corner of Greenland. The leg of the flight from Cape Bridgman to the pole cut a swath similar to Peary's of 1909, only of course wider, through the unexplored area north of Greenland. The newly opened-up patches, including those on the return voyage from the pole, are estimated by Nobile to aggregate 73,000 square kilometers. These flights only revealed Arctic pack and no land.

settled and unsettled populations is the North-West Frontier of India. To maintain

The catastrophe of the *Italia* took place, according to Nobile, at a point in latitude 81° 15′ N. and longitude 25° 20′ E. When picked up by the Russian ice-breaker *Krasin*, the survivors were about in 80° 50′ N. and 29° E. (see map at back of "The Tragedy of the Italia," by Davide Giudici, special correspondent of the *Corriere della Sera* on board the *Krasin*, New York, 1929). The best account so far published of the flight and the catastrophe is by the Czech physicist, Francis Běhounek (German edition, "Sieben Wochen auf der Eisscholle: Der Untergang der Nobile-Expedition," Leipzig, 1929). Other popular accounts of the rescue have been published by Maurice Parijanine, Russian correspondent on the *Krasin*, "The Krassin," New York, 1929, and by Captain Einar Lundborg of the Swedish air force (English edition, "The Arctic Rescue: How Nobile Was Saved," New York, 1929). Dr. Leonid Breitfuss of Berlin has attempted a critical evaluation of the flights, "Die Nobile-Nordpolexpedition mit dem Luftschiff: Verlauf der 'Norge'- und 'Italia'-Fahrten—Die Rettungsaktion—Die daraus zu ziehenden Lehren," (*Petermanns Mitt.*, Vol. 75, 1929, pp. 1–7 and 71–76). N. Evgenov gives a scientific account (in Russian) of the cruise of the ice-breaker *Sedov* south and west of Franz Josef Land in 1928 to search for the group that drifted away with airship after the catastrophe in *Morskoi Sbornik*, No. 2, 1929, pp. 43–54. It is accompanied by a map showing the different forms of ice met with en route.

WORLD AS A WHOLE AND LARGER PARTS

Aviation and the British Empire. "The advent of the air weapon has lost us our age-long security as an island nation, and has left the greatest city in the world more open to the dangers of air attack than any of the other capitals of Europe." These words of Sir Philip Sassoon, Under Secretary of State for Air (Great Britain), supply the argument of a striking paper, "The Influence of Aviation on International Affairs," by Brigadier-General P. R. C. Groves in the July number of the *Journal of the Royal Institute of International Affairs*. Great Britain is a small country well served with other means of transportation, and in the last few years she has failed to keep pace with the progress of aerial communications. General Groves quotes figures of commercial aircraft mileage for 1926 and 1928 respectively as follows: Great Britain (including the Cairo-Basra Service) 840,000; 950,000: Germany 3,816,000; 6,750,000: France 3,244,000; 4,500,000: United States 4,598,000; 10,472,000. However, the outlook for imperial air communications, at any rate, is now brighter. The line to India is in regular operation, and the opening of the Cairo-Cape Town line is in prospect.

The line to India was officially opened in the latter part of 1928 by Sir Philip Sassoon, who describes the journey there and back in "The Third Route" (Heinemann, London, 1929). The third route, it may be explained, is the way to India by air, succeeding the route via the Suez Canal which in its turn had succeeded the route round the Cape. Sir Philip's narration should contribute no little towards popularizing the route and its vehicle, for the journey as he pictures it is a series of enchantments. But "The Third Route" is more than a delightful travel story: it conveys an idea of "the vital rôle which air power is destined to play in the communications of the Empire." Sir Philip thus confirms the expression of his predecessor along the road in 1926, Sir Samuel Hoare, who in another delightful narrative, "India by Air" (1927) sees the airplane and airship "eliminating the time and distance that are now the most formidable obstacles in the way of Imperial unity."

Both authors dwell on the notable economy achieved by the Middle East Command of the R. A. F. in the defense and policing of the desert stretches between Egypt and 'Iraq. The problem is as old as civilization. The demand it made on the Romans, for instance, is revealed by the extent of their defensive works on the Transjordan border, so clearly visible from the air. Another classic area of conflict between

The mathematician requires a projection having clearly defined properties which

settled and unsettled populations is the North-West Frontier of India. To maintain that frontier on the ground has become increasingly expensive, especially since the World War introduced to the tribes modern tactics and modern weapons. "During the last twenty years of the past century the actual cost of campaigns along the frontier amounted to some £300,000. In the first twenty years of the present century the financial cost mounted to nearly £20,000,000." The airplane offers a cheap and efficient alternative method to the campaign on the ground. One instance of its efficiency is afforded by the successful evacuation of the Europeans from Kabul over the snow-filled passes in February of this year. Another striking example of possibilities of quick action—imperative in dealing with tribal disturbances—is given by Wing-Commander A. A. Walser (Flying on the North-West Frontier of India, *Journ. Central Asian Soc.*, Vol. 16, 1929, pp. 289–297). Where he spent five days, traveling from Peshawar to Chitral "going double marches on a hot and dusty road" he made the return by air in two hours!

Sir Philip compares these two problem areas thus: "Iraq, Transjordan and other Middle Eastern territories strike one as obvious countries for control by air power; because of their level, open spaces, their cloudless skies, and, generally, the favourable conditions for flying that prevail there during most of the year. Here [North-West Frontier] flying seems natural for a very different reason; because the whole face of the land is so broken and heaped up, the valleys so deep and the mountains so high, that only on wings can one move about without infinite toil and labour. It is not good country for flying; but yet country in which flying is the ideal means of locomotion."

The value of airways in Empire settlement as well as Empire defense is also touched upon by General Groves. He instances the development that has resulted from the Perth-Derby air service in Western Australia. The service covers 1400 miles in 2½ days against 13 days by steamer. From the scattered centers along the seaboard families have migrated to distances of a hundred miles and more. Roads and motor roads will follow, and eventually the railway; but here the airway is the pioneer.

General Groves, however, does not mention Canada, whose progress in aviation is truly spectacular. From the Report on Civil Aviation for 1928 (Dominion of Canada, Dept. of National Defence, 1929) we learn that the total of aircraft mileage in the Dominion increased from 393,000 in 1926 to 2,728,000 in 1928. The Western Canada Airways company alone carried nearly 10,000 passengers, over a million pounds of goods, and over 122,000 pieces of mail and flew over half a million miles last year. Their operations included the maintenance of a weekly winter service down the Mackenzie from Waterways to Fort Simpson. But mileage and passengers and freight are not all the story. One of the most impressive features of aviation in Canada is the varied use to which it has been put in the conservation and development of natural resources.

MATHEMATICAL GEOGRAPHY

Recent Developments in Map Projections. There has recently been a distinct revival in general interest in the subject of map projections, particularly of those purporting to show the whole sphere. The merest novice knows that the perfect map is impossible, and yet almost every one with a constructive mind who has touched even ever so lightly on the surface of the technical field of map projections has bethought himself of a "new" map projection. In view of this it seems important that there should be a clear definition as to what is meant by a *new* map projection. It seems also appropriate to point out the widely divergent ideas held by those who are actively engaged in trying to improve the graphical representation of a spherical surface on a flat piece of paper as to what constitutes a *good* map projection.

Mr. S. W. Boggs's new equal-area projection is likely to be of considerable use in a practical way as it is approximately a mean between the sinusoidal and the Moll

The mathematician requires a projection having clearly defined properties which can be expressed rigorously. To him the number of individual projections is comparatively few, and most of the map projections are classified by him as variations of one or other of these basic types. His interest is often purely in the elegance of the mathematical conception rather than in the practical application. On the other hand the educator is generally content with a good pictorial representation more or less suitable for all purposes and in his ignorance of the theory will often acclaim as a good general map one such as Mercator's which is misleading in almost every respect if its properties are not understood. It is the professional geographer who takes the middle course. He realizes that there is probably a best map for illustrating any particular set of conditions. Sometimes he requires the property of equal area, sometimes the property of orthomorphism. Sometimes he wishes his map centered at a particular place on the earth's surface. His needs are many and various, and he abhors the limitation or standardization of his map resources.

Nevertheless, many map projection enthusiasts concentrate in attempting to obtain an improved general map of the world for the purposes of showing distributions, etc. Most people agree that the property of equal area is an essential to such a map, but there agreement stops. Some object to curved meridians or parallels, others prefer these to great shape or scale distortion at the extremities of the map. Some will interrupt the surface of the sphere in many places in order to maintain shape, often needlessly sacrificing continuity. Others make a fetish of continuity at the expense of shape.

At present there are three kinds of "new" map projections. The first is "new" because the sphere has been interrupted in a new manner. The second is "new" because the center of the projection is taken to represent a geographical position heretofore not employed, or the original projection has been extended, as for instance, in the case of the hemisphere extended to include the whole surface of the earth. And the third is new because it involves a new mathematical conception or geometrical construction to define it.

Of these three only the last is truly a new projection. The second often requires additional formulae or geometrical construction to develop it from the basic projection, but the first is merely a convenient arrangement of an old projection. It would seem most desirable that these three types of "new" map projections should be differentiated. This would be simple. The first could be called a new arrangement of the given projection; the second a new development of the projection; and the third a new projection.

It is not meant to imply that a new arrangement of an old projection cannot be as useful an achievement as a brand-new projection. Quite the reverse is often the case. A new projection may have no really practical application, while a new arrangement or development of an old discarded projection may be of great consequence. Nevertheless, the advent of a new projection having new qualities or qualities better in some respects than any other projection indicates an important achievement; and it is only right that those whose endeavors lead them towards investigating arrangements of old projections, however useful these may be, should acknowledge the distinction by properly describing their own work.

Two interesting new projections are, first, the conformal projection of the sphere within a square by Oscar S. Adams (*U. S. Coast and Geodetic Survey Special Publ. No. 153, Dept. of Commerce*, 1929), and, secondly, Mr. A. R. Hinks's retro-azimuthal projection of the world ("New Map Projections," a series of papers in Vol. 63, *Geogr. Journ.*, pp. 241–253). The first is definitely a mathematician's map projection and is not likely to be used much if ever in practice by geographers. The second, although it serves its purpose and is thus justifiable, has the distinction of being a projection of the sphere (the word projection here is used, as in the rest of this note, in its broadest sense) on which it is impossible to draw a recognizable map.

mocks of the "valleys" are formed around the vegetation, which is almost wholly

Mr. S. W. Boggs's new equal-area projection is likely to be of considerable use in a practical way as it is approximately a mean between the sinusoidal and the Mollweide projections (see *Geogr. Journ.* as before; also *U. S. Coast and Geodetic Survey Special Publ. No. 60*, revised to May 1, 1928; Elements of Map Projections, by C. H. Deetz and Oscar S. Adams).

Recent developments of the Mollweide equal-area projection are to be found in *Ordnance Survey Professional Papers No. 11* (*N. S.*), 1927, "The Transverse Mollweide," by Colonel Sir Charles Close. The latter has more recently developed a general formula for the oblique Mollweide. Examples of developments of the Mollweide have recently been drawn. In the autumn, 1928, issue of *Geography* there is an example by Mr. J. Fairgrieve, and the staff of the School of Surveying of the American Geographical Society have constructed one from independent computations. The latter differs from the conventional Mollweide only in that it has been tilted so that the center of the projection is at 20° North. An example of the oblique Mollweide also appears in Harmsworth's "New Atlas of the World," page 484.

Professor J. Paul Goode continues to investigate useful new arrangements, and the University of Chicago Press has recently published an addition to Goode's Series of Base Maps and Graphs. This is entitled "Goode's Polar, Equal Area Projection for the Continents" and is an admirable arrangement of Werner's equal-area projection in that it shows the relationship between the north pole and the land masses with very little distortion. There is an insert map of the south polar regions on Lambert's azimuthal equal-area projection. In the discussion following a paper entitled "A New Map for Meteorologists," by B. J. S. Cahill, in which the author advocates the use of his patented map for world weather information, comparisons were made between the latter and Professor Goode's new map (see extract of paper in *Bull. Amer. Meteorol. Soc.*, March, 1929, Vol. 10, pp. 66–67. Mr. Cahill's and Professor Goode's papers have been published in the *Monthly Weather Rev.* for April, 1929).

Before concluding this note mention should be made of Mr. E. A. Reeves' new device for obtaining by means of a diagram, without computation, the true bearing between two points on the earth's surface, and finding the latitude and longitude of points on the arc of a great circle between two stations (*Royal Geogr. Soc. Technical Ser. No. 5*, 1929). This admirable invention is avowedly not a new map projection. It is based on a conventional geometrical projection. Its uses are many, one of the most important being that it enables one to plot great circle courses on any kind of small scale map projection without computation.

PHYSICAL GEOGRAPHY

Dunes and Their Relation to Climatic Studies. At Repetek, about midway on the railroad between Merv and Bukhara, the Russian government maintained a meteorological station from 1913 to 1918 and revived it again in 1926–1927. In the second period botanical and other studies have also been carried on, and here Arved Schultz made his headquarters for a detailed study of the dunes (Morphologische Beobachtungen in der östlichen Kara-kum-Wüste (Turkestan) 1927, *Zeitschr. für Geomorphologie*, Vol. 3, 1928, pp. 249–294).

The climate of Repetek is truly arid with a mean precipitation for the years 1913–1917 of 94 millimeters (3.7 inches). The summer is rainless, except for rare storms such as occurred in June, 1926, and has an air temperature reaching up to 50° C. (122° F.), while the sands become heated to 80° C.

The region of Repetek consists of great belts of dunes 5 to 20 kilometers long separated by sandy flats or "valleys" 1 to 7 kilometers broad. The flats are apparently remnants of an ancient drainage system. The belts of dunes have a steep slope 30 to 65 feet above one "valley" and a transition into the other. The sandy hum-

mocks of the "valleys" are formed around the vegetation, which is almost wholly dependent on the water table. In the lower parts of the "valleys" water lies about 11 feet below the surface and in the higher parts more than 24 feet below.

The dunes are almost completely reversed each year, as the strong south winds of winter undo the work of the more continuous but lighter north winds of summer. In spite of this complete change in slopes the dune ridges and dune masses consist of barchan-like forms, although only about five per cent of the dunes are true barchans. The true barchans consist of subtypes: (1) the normal barchan, (2) the reversed barchan, (3) the disarranged barchan of four kinds (twin barchans by junction of neighbors and by overriding of one over another; longitudinal and transverse sickle-like mounds), (4) the cross barchan, (5) the sand mound, (6) the sand ridge, (7) the sand heap. The shapeless forms of 5, 6, and 7 are regarded as degenerate or incipient barchans. The cross barchans are small barchans that lie at the foot of the steep slope of larger forms and are due to a cross wind sweeping around the end of one wing of the barchan.

Clayey banks, sand heaps around bushes, and other minor features characterize the depressions between dunes. The fact that the material between dunes and in the valleys is generally finer and, in places, compacted by clay and by plant roots is cited to show that a firm base is necessary for the formation of barchans. A supply of sand and wind would produce only irregular heaps and wind ripples. This conclusion seems to be only partially true, as their critical factor is the supply of sand. If too much is furnished, irregular dune areas of longitudinal or transverse type result; whereas a moderate supply of sand produces barchans. Obviously the existence of a firm base prohibits the pick-up of new sand and thus regulates the supply. Also the base must not be too damp or have too heavy a vegetative cover, or the movement of the sand is hindered and the true barchan cannot develop.

Schultz's attempt to place the forms of the sand in this area in a developmental series which can be used as an indicator of past climate is not comparable in value to his observations on barchans. We may be sure on other evidence that the dune areas of the Kara-kum developed under a fluctuating climate, but his correlations appear premature.

The value of dune studies of this type is very great. The literature on dunes is enormous, and yet many problems are far from solution. Thus Herbert Louis (Die Form der norddeutschen Bogendünen, *Zeitschr. für Geomorphologie*, Vol. 4, 1929, pp. 7–18) presents a new study of the much studied North German dunes. These bow-shaped dunes with the curve of the bow to the east have a superficial resemblance to barchans, but the steep slope lies on the outside of the bow; and, as revealed by road cuts, the internal structure shows that the lee side is to the east. They must have been formed by westerly winds. But, as the south wing of the crescentric ridges has almost equal slopes, Louis holds that the dunes were modified by southwesterly winds. As the dunes are now fixed in position by forests they furnish a record of the wind system of the past. A west wind during the retreat of the Würm (Wisconsin) ice may have formed the dunes and have been followed by southwesterly winds of the present time. Thus Louis rejects the interpretation of Solger and follows Högbom and Hörner in their interpretation of the Swedish dune areas. The arguments of these authors that the bow-shaped dunes of Sweden and Germany should be interpreted as being formed by a wind blowing in the direction of the arrow in the bow must obviously be accepted. Nevertheless the conditions that lead to the formation of dunes of this shape are not yet known. In all deserts today barchans whose wings point in the direction of the wind are normal forms. Even on the famous Kurische Nehrung the dry sand moving over the underlying damp sand will, with a steady wind of one or two days' duration, form a barchan 25 feet high (F. M. Exner: Über Dünen und Sandwellen, *Geogr. Annaler*, Vol. 9, 1927, pp. 81–99). Obviously some special condition must have existed in the sand

plains left by the retreat of the ice. The further study of dunes may lead to an explanation of this special condition. At the same time the development of suitable criteria may make possible such valid interpretations of the wind conditions of the past as to lead to important conclusions not only in areas within the influence of the continental ice sheets but in desert regions. With the development of such criteria arguments as to the succession of past climates as attempted by Schultz will gain greater credence.

KIRK BRYAN

HUMAN GEOGRAPHY

Cycles in Metal Production. In a paper of this title Dr. D. F. Hewett of the U. S. Geological Survey presents a series of curves showing the annual production of the principal metals (iron, copper, tin, lead, silver, and mercury) for the outstanding mining districts of Europe and the United States (*Amer. Inst. of Mining and Metallurgical Engineers Tech. Publ. No. 183*, 1929). Analysis of these curves and comparative study of the broader history of the metal industries in Europe lead him to certain significant generalizations. Maximum production has tended to shift during the past 125 years from one country to another. Thus, "districts in Norway, England, and Spain [have been] successively outstanding sources of copper, and in England, Germany, and Spain, of lead." Declines in production from most of the districts and declines in the grades of ore treated have been characteristic of recent years. Within each nation, moreover, each metal industry would seem to pass through a sequence of "life stages." The peak in the curve of exports of crude ore is usually passed early in the history of the industry. As more mines are developed, local smelters and refiners are established; and these absorb the domestic ore, cutting down exports. Under ordinary conditions many small and unprofitable deposits are worked experimentally and abandoned before it becomes "known where the largest and richest bodies of the district lie." It follows, therefore, that the peak in the curve for number of mines is also passed relatively early, before the maximum number of smelters and refiners and the peak in production have been reached. "Finally, with the failure of local sources of ore and the maximum advance in technique, smelters and refiners not only need but attract ore from remote sources, and trade in imported ore naturally begins. Whether and how long metallurgical industries survive depends upon the local fuel and power supplies and the maintenance of competitive technique."

There is also a tendency, well defined in frontier regions but apparent even in Europe, for metal production as a whole to pass through successive epochs: "an age of gold, then of silver, then of copper, then of lead and of zinc, then of iron" (Louis de Launay: Le conquête minérale, Paris, 1908, p. 27, as cited by Hewett, *op. cit.*, p. 28). This order, Dr. Hewett points out, corresponds to "the order of prices [that] has been maintained for several hundred years [and] represents roughly, also, the order of abundance of the metals as shown by production in recent years."

On the whole, the "immediate outlook for an increase in metal production in Europe is not encouraging, iron possibly being excepted." In the United States the district production curves make it clear that "many of our outstanding districts of a few years ago show signs of exhaustion, and [that] we are sustaining or increasing national totals by turning quickly to new sources of lower grade. If science and technique can keep up the pace, we have no cause for concern." Dr. Hewett, however, doubts that they can do so much longer.

The Harris Institute Conference on Population. Population and migration were the subjects discussed at the Sixth Institute of the Norman Wait Harris Memorial Foundation for the Study of International Relations, which was held at the University of Chicago, June 17–28, Professor Quincy Wright acting as chairman.

The outstanding fact developed by the round table discussions was the prospect of a stationary population in northern Europe (excluding the U. S. S. R.) and in the United States within a generation. Indeed, in England and Germany the birth rate has fallen so low that the population will not be maintained after the present generation of young people become old. Unless, therefore, the birth rate reverses the present downward trend, or unless extensive immigration sets in from southern or eastern Europe, it appears inevitable that the population of these two nations, and probably of other nations in northern Europe also, will decline after reaching a maximum 20 to 30 years hence. This fate will overtake the United States also if the birth rate falls much below the present level, unless immigration laws are changed.

The significance of this prospect to the farmers of the United States, to urban property owners, to tenants, indeed, to almost every one, can scarcely be overemphasized. Agricultural production in the United States at present, except of sugar and certain tropical products, is almost sufficient for 150,000,000 people having the present standard of living, and it is probable that there are almost enough houses or apartments in the cities for a population of this size. Since building construction is certain to continue, though probably to a lessening extent, it is likely that the less desirable houses in the cities will depreciate greatly in value in the course of a few decades. Since the less desirable farm lands in the country have been declining in value for years, they will be less affected. Indeed, it is not unlikely, in view of the industrialization and increasing population of Asia, that the value of farm land in the United States may rise slightly as exports increase.

Of course, if the prospect of declining population should prompt the American people to modify their immigration policy, these economic consequences might be avoided and the era of high prices maintained for such products as were not sold on the world's markets. There is no sign yet of appreciable voluntary restriction in population in the U. S. S. R. or the Orient except in Japan, and the higher standard of living in the United States would undoubtedly be very attractive to the people of these countries, as it has been in the past.

The Proceedings of the Conference will be published late in the autumn by the University of Chicago Press.

O. E. Baker

OBITUARY

Émile Chaix. The *Journal de Genève* for May 15 announces the death of Émile Chaix, professor of physical geography at the University of Geneva, at the age of 74. Early in his career Professor Chaix resided in Russia and later acted for a time as secretary to the Swiss legation in Belgrade. Travel in various Russian and Serbian regions and especially close observation of natural phenomena in those "pays tourmentés" of the Dinaric Alps led him to physical geography. His work in this field includes studies of vulcanism in Italy, notably the construction of a fine map of Etna on a scale of 1 : 100,000 (1892); of coast erosion in the Channel Islands; of erosion by running water in alpine valleys; of solifluction; and especially of lapiés. Some of these studies were carried out in conjunction with his son André, with whom he also made investigations in the Swiss National Park in the Engadine. He was a member of the American Geographical Society's Transcontinental Excursion in 1912 and contributed a paper on some geysers of the Yellowstone to the Memorial Volume. The results of his researches, however, are published for the most part in *Le Globe*, the journal of the Geographical Society of Geneva.

Professor Chaix was not only a student but also an admirable teacher. As an ardent believer in the value of illustrative material—photographs and maps—as a means of instruction he advanced the idea of the "Utilité d'un atlas international de l'érosion" (*Le Globe*, Vol. 45, 1905) and, having secured the coöperation of Jean Brunhes, presented his plan before the Ninth International Geographical Congress

which met at Geneva in 1908. In somewhat more comprehensive form it materialized as the "Atlas Photographique des Formes du Relief Terrestre" (Album of Landforms), published under the auspices of an international commission by an executive committee consisting of MM. Brunhes, Chaix, and Emm. de Martonne. The first installment appeared in March, 1914, and thereafter the war put a stop to further publication. At the Cairo Congress in 1925 a resolution was passed for resumption of the work under the International Geographical Union.

For many years the Chaix family has played a prominent part in the activities of the Geographical Society of Geneva—Émile, his distinguished father, Paul, and his son, André—"belle dynastie de géographes," as Eugene Pittard says in a sympathetic memorial appearing in the June number of *Der Schweizer Geograph*. Émile Chaix, like his father also, was a Corresponding Member of the American Geographical Society, being elected in 1889.

Hans Meyer. Professor Hans Meyer, well known for his studies in colonial geography, died in Leipzig on July 6, 1929, aged 71 years. His work was essentially directed towards the placing of colonial policy on a sound basis by resting it on a scientific knowledge of the colonial regions and their peoples. His first travels took him round the world in 1881–1882, on which occasion he devoted special attention to the Philippines. In 1886 he began his series of African journeys, of which the crowning event was his conquest of Africa's magnificent mountain Kilimanjaro, described in "Across East African Glaciers: An Account of the First Ascent of Kilimanjaro" (London, 1891). "Der Kilimanjaro" (Berlin, 1900) is the narrative of the fourth expedition and a summarizing of the author's observations on past and present glaciation in East Africa. This subject, the glaciation of high mountains in the equatorial regions, was one of Meyer's particular interests, and he later carried his studies therein to South America ("In den Hoch-Anden von Ecuador," Berlin, 1907).

Dr. Meyer was instrumental in the organization of the Landeskundliche Kommission zur Erforschung der deutschen Schutzgebiete, which prosecuted research in the German colonies, both by the promotion of field studies and the publication of results in its magazine, *Mitteilungen aus den Deutschen Schutzgebieten*, and in a series of monographs. As his own share in this work Meyer published in 1909 the admirable "Das Deutsche Kolonialreich," in five parts, himself contributing the section on "Ostafrika." He is also the author of volumes on "Die Barundi" (Leipzig, 1916) and "Das portugiesische Kolonialreich der Gegenwart" (Berlin, 1918).

A biographical sketch of Dr. Meyer by Karl H. Dietzel appeared in *Geographischer Anzeiger* (Vol. 29, 1928, pp. 73–76), and a bibliography of his writings in "Koloniale Studien" (Berlin, 1928)—a *Festschrift* of interesting papers commemorating his seventieth birthday.

GEOGRAPHICAL REVIEWS

Siberia Under the Soviet Régime

Georg Cleinow. **Neu-Sibirien (Sib-krai): Eine Studie zum Aufmarsch der Sowjetmacht in Asien.** xv and 426 pp.; maps, ills. Reimer Hobbing, Berlin, 1928. RM. 30.

It would have been better had the contents of this book been put into two volumes, the first a scientific discussion of Siberia, the second comprising the ideologies of the author. He is less interested in Siberia as nature presents it than he is in what the Soviet authorities may make of it in the way of a self-contained political and economic realm. It is the fate of Siberia to have all of the new problems of a pioneer society on a large scale and at the same time to be taken as a field of experiment by a small group of men (there are only 61,500 communists in a population of 8,000,000) who are trying to reorganize society. The "dictatorship of the proletariat" runs into the difficulty of finding how to make and keep a proletariat in a frontier society where extractive industries are the rule and capital is lacking with which to encourage industry that may serve the double purpose of making a better-balanced economic life and furnishing "members for the party." The outstanding fact in the present economic organization is the regional division of the country, its *rayonierung*, as it is termed, by which means it is hoped to work out a collective economic development on a broad scale under centralized control. Side by side with this plan there is an attempt in Siberia to work out the development of nationalities (of which six principal ones are recognized) so as to provide for what is termed "kulturpolitik" decentralization—the idea of associated republics versus an imperialistic state. At least so far into politics are we obliged to go to understand the political map of Asiatic Russia today.

Among the geographical elements the most important by far are those that relate to pioneer settlement and the way it is being conducted today from the railway base, chiefly the Trans-Siberian Railway and its feeders along the Asiatic extension of the *chernozem* or black-earth belt. There is no one Siberian type of land use; there are types as varied as the land itself and the people. Often each village is a law unto itself because of the variety of places and cultures represented in the population. There are numerous religious sects from various parts of old Russia, as well as Germans, Poles, Letts, Esths, Tatars, Kirghiz, and Kalmucks, in scattered settlements in the west; and there are over 600,000 Mongols in addition to the bulk of the population (with over six million White Russians heading the list) drawn from thousands of Russian villages. Since agriculture at first meant only food for domestic use, and still means that to large degree, it was natural that "the size of the family was and is the measure of the wealth of a Siberian farmer." There is a high percentage of young married couples. There is much coöperation of neighbor with neighbor in seeding and harvesting as well as in the use of machinery, tools, and draft animals, one man contributing a plow, the other a horse. There is a valuable account of the mode of development of the Kusnetsk-Altai region. When the number of farms had grown to the point where all the land about a village was occupied, and every person and domestic animal was economically employed, another village came into being on the margin of the territory occupied by the first. There was difficulty in the grazing of the land wider afield because of lack of capital and danger from wild animals. If labor was required for public works or industrial development it had to be imported, because every man was anchored upon his own land. A message

was sent to the home village in Russia and new immigrants were attracted, not by the promise of a wage but by the offer of land which the employer could get through his influence with the government. But the new settler was economically and politically bound to the employer through the device of an advance to him of provisions and tools.

How the squatter operates on the frontier is the theme of one section, and the floating population another, with much comment upon the process by which settlers try to gain independence by going beyond reach of government in many a corner of the remoter steppes and forests. The economic development of the land by close settlement requires railways and highways, and the lack of both produces effects here vividly set forth—the long broad tract (five to ten kilometers wide) over which the carts go in summer, narrowing to a focus at a stream crossing or a swamp or a railway station. Tributary roads come in over the prairie in direct lines, cross-lots, so to speak; and the tendency is carried even further in winter, when streams furnish new if temporary highways and change the pattern of the roads, the whole countryside being under deep snow and transport going any way it pleases. Automobile roads would help transport enormously, says the author, and they would intensify the use of the land even if at first only a limited number of trunk lines could be built.

First in importance in bettering transport and economic development is the improvement of railway communications between the cotton-and-dried-fruit region of locally irrigated Russian Central Asia and the grain-growing region of Western Siberia. Russia requires more and more cotton and cotton goods, and the Siberian and Turkestan region can largely supply them. The author sees the great advantages of a textile industry created in the area of cotton production not merely for the good of the region but also to supply the growing need for textiles in Mongolia and western China, of whose political importance to Russia he has much to say. This would have the effect of reducing transport costs on cereals to feed the cotton districts and would lead to a largely self-contained Central-Asian economic unit. The trade outlets and conditions are analyzed, the Ob and the Yenisei and the Kara Sea route and the difficulties of shipping out the raw products of an extractive economy to distant European markets. The chief trade needs of China's outer territories in Asia being manufactured wares, Russia is in no position to supply them, but she may compete in textiles ultimately. The dairy business is especially emphasized, for it may be increased to supply the capital needed for other than purely agricultural purposes. Statistics are given, and some analyses of them, for the export and import trade, its trends, and the forms of production that can most readily be increased under present conditions.

Altogether this is the leading book on Siberia, as it claims to be; which makes it a pity that the maps are not more than rough sketches, that the number should not have been greatly increased to enable the reader to follow the detailed text, and that the absence of an index requires each reader to construct his own if he wishes to consult this highly useful volume again.

Lattimore and Sven Hedin in the Gobi

Owen Lattimore. **The Desert Road to Turkestan.** xiv and 331 pp.; maps, ills., index. Methuen & Co. Ltd., London, 1928.

Sven Hedin. **Auf grosser Fahrt: Meine Expedition mit Schweden, Deutschen und Chinesen durch die Wüste Gobi 1927–28.** xii and 347 pp.; map, ills., index. F. A. Brockhaus, Leipzig, 1929.

The routes across the heart of the Gobi followed in 1926–1927 by Lattimore and a year later by Sven Hedin were approximately the same. Both travelers journeyed from Peking to the Mongolian frontier by rail; both struck directly over the Alashan

Desert to the strange river Edsin Gol, which loses itself in two salt lakes; and thence over the Black Gobi to Chinese Turkestan. Lattimore tells us that this route is known as the "Winding Road" and that of late years the Chinese trade caravans have been following it rather than the old, established routes farther north. By taking this difficult passage they keep as far as possible to the north of "Chinese officials collecting *likin* or transit taxes" and far enough to the south of the independent Mongol tribes to avoid confiscation of their goods. The latter evil may be attributed to Soviet influence, which is attempting "to bind Mongolia economically to Russia" by enforcing "a prohibitive discrimination against Chinese trade." Although parts of the territory traversed by the "Winding Road" had been visited by other explorers, Lattimore claims to have been the first "to follow it throughout with a conscious interest in its history and its relation to the other great highways of inner Asia."

The latter portions of the journeys of Lattimore and Sven Hedin were made in the late autumn and winter. Both travelers had to contend against the hardships and dangers of the fierce mid-Asiatic winter, and both encountered suspicion and active opposition from the local authorities when Chinese Turkestan was finally reached. Lattimore was detained for several days in the miserable town of San-t'ang Hu, and at one time it looked very much as if the entire program of the Sven Hedin expedition would fail owing to the hostility of Yang Tsen Hsin, at that time the powerful governor of Sinkiang (Chinese Turkestan). Yang, however (about whom Hedin gives some interesting details), was finally won over and did all he could to promote the success of the expedition. But at best the complicated cross currents of political intrigue engendered by the Chinese and Russian revolutions have raised difficulties for the present-day explorer in Mongolia and Central Asia that were unknown before 1911.

Although the routes followed and the troubles encountered were similar, two more unlike journeys could hardly be imagined, nor two more unlike books recording the results. Lattimore traveled alone with a trusted Chinese servant and a few hired camels and their attendants, sometimes joining a commercial caravan for a longer or shorter stretch. His purpose was "to break with the office life of the fringing coastal ports, to go somewhere a long way off, to countries where men do things as they were done uncounted years ago, because their fathers did things in that way." Elsewhere he writes: "Those were high days for dreaming, before the cold began and the really arduous marches. Part of the magic of Mongolia is in the satisfying physical joy of immersion in the life of monotonous fatigue and simple laziness; the shifting landscapes, the feeling of bodily exaltation in the proud distances and swinging marches. Part of it is in learning the tone and spirit of men whose crude but tradition-informed manners and society are only a rough balancing of physical needs; in long idle talking not made brittle and false by thought, and in longer, idler silences."

Knowledge of their language and a sympathetic spirit of understanding gained for Lattimore the confidence of "camel pullers," desert rovers, bandits, and village folk, who seemed to forget that he was a foreigner and would talk freely and naturally with him. His was not a "scientific" expedition, in that he did not attempt to make precise, quantitative measurements. He used no calipers on Mongol crania and no theodolite or plane table on the Mongolian landscape. Some of the time he did not know exactly where he was, and it would be difficult to plot his route on a large-scale map. The poetic, subjective note struck in many passages throughout his book, however, lends it an unusual charm, and the curious and obscure facts recorded about the lives and traditions of the people of the Gobi are of rare value and interest. We learn, for instance, of the great trading firm of Ta Sheng K'uei with headquarters in Kuei-hua, which "has been established for more than two hundred years; it has a history that would stand well beside that of the Hudson's Bay Company." Latti-

more has little sympathy for the Chinese policy of agricultural settlement in Mongolia. "The Chinese are evicting the Mongols, as near as I can compute, at about the rate of 10 miles a year, all along the edge of the red and blue and gold and purple Back Country, behind the Ta Ch'ing Shan," but the movement will not solve the problem of overpopulation. "This vice in Chinese political economy might be corrected by saner marriage customs; certainly never by merely expanding the area of their breeding-grounds and burial-grounds."

Sven Hedin's party consisted of eighteen white men, ten Chinese, thirty-four servants, and, at one time, 392 camels. The European staff consisted of Swedes, Germans, and a Dane; it included a geologist; a physician who took anthropological measurements on the side; an archeologist; three meteorologists; a "navigating officer" who operated the wireless receiving set; a moving-picture man; a treasurer; several people in charge of the supply train, as well as general utility men. The Chinese staff comprised specialists in archeology and meteorology, together with five students. A vast quantity of impedimenta was taken along, including a library of Chinese historical works bearing upon the regions visited. The expedition was normally divided into three columns which swept the country over a broad front; triangulation nets were established, topography was sketched on the plane table, special geological and archeological maps were made, meteorological observations taken, and sounding balloons sent up daily. During prolonged halts special parties were sent out to visit neighboring localities. Never has a more elaborate and comprehensive exploring expedition penetrated the heart of Asia. The government at Peking had at first offered opposition, but finally the matter was adjusted by arranging to have the Chinese scholars take part in the work, with what appear to have been admirable results, for Sven Hedin gives a glowing account of the harmony that at all times prevailed. The primary purposes of the Chinese members were the making of archeological and meteorological observations and the establishment of five permanent stations in central Asia to coöperate with the observatories in China in the preparation of weather forecasts.

Sven Hedin sent his book to the publisher in August, 1928, during a brief sojourn in Sweden before returning to Chinese Turkestan. Notices in the press indicate that the work of the expedition was continued through last winter and will be carried on over one or two years more.

"Auf Grosser Fahrt" is a lively and vigorous narrative of the first year's experiences written for the general public. It tells us a great deal about the conduct and daily life of the expedition and the difficulties encountered and also something of peoples seen and country traversed. The scientific results of the expedition when finally published should be very impressive and should go far toward removing those last traces of the glamor of the unknown that still lingered over the Gobi when Lattimore made his way across it.

Problems of the Pacific

J. B. Condliffe, edit. **Problems of the Pacific: Proceedings of the Second Conference of the Institute of Pacific Relations, Honolulu, Hawaii, July 15 to 29, 1927.** xiii and 630 pp.; maps, diagrs., index. Univ. of Chicago Press, Chicago, 1928. $3.00. 9½ x 6½ inches.

No geographer who deals with the Pacific area can afford to be without a working knowledge of this book. He would do well to begin with a chapter near the end entitled "The Human Potential in Pacific Politics" by Herbert Croly. There he will find the case of disinterested research set forth with a breadth and penetration altogether unusual, which stamps this paper as the leading contribution of the book. Croly describes the object of the Institute of Pacific Relations as an attempt "to give reality to the vision of the Pacific as an area of positive political association among

the inhabitants of its shores, . . . " He goes on to say that its purpose is to inquire, study, and consult in order to be aware of the processes of life among the Pacific peoples and believes that because of such comprehension, creative work will be done. Anyone who reads page 585 in Croly's paper (dealing with the problem of surplus population in Japan) and then turns to the most important scientific paper in the volume, that by Dr. Shiroshi Nasu on "The Problem of Population and Food Supply in Japan," will find himself almost in a new world of understanding. The views of these two writers are in opposition, and yet each view is so temperately and reasonably expressed as to make it possible to continue the discussion in later conferences, and thus see what approach to agreement may be made. Nasu points to the effort that Japan is making to solve the problem of surplus population and how restricted will be the benefits of even the most intense application of science to the problem on the Japanese homeland. He asks a more just international relationship for Japan in the light of these desperate efforts and Japan's ever more desperate condition. By contrast Croly can see no relief through the export of population or manufactures to other countries in larger measure unless the Japanese themselves try persistently and intelligently to reduce the volume of their surplus population. He can see "no stable international pacification unless the progressive societies set up an intelligent censorship over the increase of population."

The other papers in the volume might be said to revolve in an orbit with two foci, one set up by Croly and the other by Nasu. After reading their arguments, one turns with heightened intensity of interest to the meaning of the technical papers that comprise the greater part of the volume. Special mention should be made of the well-organized and intelligent papers by Baker on "Land Utilization in China" and "The Progress of Population," of Alsberg's "The Factors That Govern Population Growth," and of a great variety of papers from specific standpoints, namely those on the population of the Philippines, New Zealand, Korea, Australia, China, and Japan. While the papers are unequal in value and some of them vague and confused in their geographical or economic or social implications and arguments, they are all informing, all worth while. All of them are prompted by the spirit of inquiry and accommodation rather than that of propaganda or special pleading. The volume is a new point of departure in critical studies in the Pacific area, whether these lie in the field of geography or economics or statesmanship.

Contributions to Mexican Geography

Maximilien Sorre. **Mexique; Amérique centrale.** 234 pp.; maps, diagrs., ills., bibliogr., index. (Géographie Universelle, Vol. 14.) Librairie Armand Colin, Paris, 1928. 60 fr. 11½ x 8 inches.

Ernest Gruening. **Mexico and Its Heritage.** xix and 728 pp.; map, ills., bibliogr., index. Century Co., New York and London, 1928. $6.00. 9 x 6 inches.

Frank Tannenbaum. **The Mexican Agrarian Revolution.** xvi and 543 pp.; maps, diagrs., bibliogr., index. (The Institute of Economics of the Brookings Institution.) The Macmillan Co., New York, 1929. $2.50. 7½ x 5 inches.

The close proximity of the primitive and the modern in a country of sharply contrasting types of environment has created a geographic mosaic too intricate to be explained in a single volume. Only by studying the phases of Mexican life individually and superimposing them on a background of environment can one hope to obtain an adequate understanding of the country. In "Mexique; Amérique centrale," Volume 14 of the admirable "Géographie Universelle" series, Maximilien Sorre has presented a foundation for further investigation in both Mexican and Central American geography. The four sections of the book contain a general

introduction to the geology and physical geography of the countries bordering the "American Mediterranean" and more detailed geographic studies of Mexico, Central America, and the Antilles.

About a fourth of the volume is devoted to Mexico. As the author states, "The distribution of the land combined with a geographic condition which renders internal communication difficult, the semidesert character of a large part of the country, an incomplete fusion of races, and arrested development on the part of one faction of the population contribute to explain the unequal and retarded conditions in Mexico. These relationships will be established by a regional study of the country." On a basis of physical geography, climate, and vegetation the country is divided into regions ranging from rainy tropical lowlands to desert plateaus. Limited space precludes the development of other than the major geographical relationships such as types of agriculture, location of railroads, mining, and the position of cities. In no case does the individual Mexican emerge. Political and military geography are omitted, though certain locations like Chihuahua and Sonora, rendered inaccessible because of distance from the capital, and Morelos and Jalisco, difficult of access because of mountainous topography, seem to be perennial centers of revolt. Especially favored positions such as the Laguna cotton-producing district and the port of Vera Cruz are repeatedly foci of attack. But, because of its fundamental character, further development of industry and changing political conditions will detract little from the value of "Mexique; Amérique centrale."

"Mexico and Its Heritage" is not geography. To a large extent it ignores environment. The major social forces of Mexico, such as the church, the army, land systems, labor, and the revolutionary movement, are considered historically and in relation to one another. Conditions in Mexico are like a pendulum swinging from one extreme to the other. The oppressed faction has always merited sympathy, but on attaining power it has resorted to excesses that have alienated this sympathy.

The present political and social conditions of the country are regarded as an outcome of the conflict between the Indian majority and the ruling Spanish minority. "Both nationalities are worse off for their unnatural relationship. That is the Mexican's racial inheritance." The Catholic Church, the Spanish language, and the republican form of government are but a veneer that conceals the Indian character of the nation. Indians now make pilgrimages to worship the Virgin at Guadalupe where, before the advent of the Spaniards, they paid homage to Tonantzin, the goddess of the earth and corn. The Mexican language has been enriched by additions from the Nahautl, and in the remoter sections of the country the Spanish language is still unknown. President Juarez, of the last generation, and General Amaro, the present Secretary of War, are among the exceptions who prove that the Indians are still capable of producing national leaders. In general it is the mestizo who capitalizes his Indian ancestry to gain popularity, and his official position to gratify his personal ambitions. However, it is worth nothing that expenditures for public health have increased sixteenfold since the time of Diaz, rural schools are being opened, and real efforts are being made to develop the talents of the Indian rather than to cast him in the mold of the Spaniard.

The volume is without bias; it is carefully documented and is accompanied by an excellent bibliography and a selection of illustrations representative of Mexican life. Though often ponderous, "Mexico and Its Heritage" does convey the impression of Mexico as a nation composed of separately operating states and dominated by unfortunate social forces whose roots extend back to the time of the Spanish conquest.

With the exception of the thirty-five-year rule of Diaz, Mexico has been in a state of continual revolution since 1810. The revolution against Spain, motivated largely by agrarian ambitions on the part of the Indians, resulted in independence but failed to gratify those ambitions. Effort on the part of Diaz to settle the problem

of land boundaries resulted in a more rapid concentration of land, particularly in the hands of foreigners. This was the basis of the revolution of 1910. The situation subsequent to that date has been analyzed by Frank Tannenbaum in the "Agrarian Revolution in Mexico." Article 27 of the Constitution of 1917 defined and limited landownership and furnished a formula for the solution of the land problem, and Article 123 established the rights of the worker. By reason of its concentration in pueblos, the rural population, as well as the industrial population, is able to demand its rights as a group. The operation of these two articles has freed 47 per cent of the agricultural population of Mexico from peonage. Access to the files of the national and state governments in Mexico has enabled Tannenbaum to present an abundance of material never before published in the English language. From the maze of ambiguous data he has extracted valuable information as to the size and value of landholdings in Mexico and the actual amount of land owned by foreigners. The material accomplishments of the National Agrarian Commission have been traced through 1928; but the greater significance of the Mexican Revolution lies in the fact that "Mexico is the first of the Latin-American states in which the mass of the underlying population has achieved access to political dominion in more than a figurative sense."

Problems in the Physical Geography of Palestine

Bailey Willis. **Dead Sea Problem: Rift Valley or Ramp Valley?** Map, diagrs., ills. *Bull. Geol. Soc. of America*, Vol. 39, 1928, pp. 490–542.

Bailey Willis. **Earthquakes in the Holy Land.** Map, diagr., ills. *Bull. Seismol. Soc. of America*, Vol. 18, 1928, pp. 73–103.

On July 11, 1927, much destruction was caused by an earthquake in Palestine. Bailey Willis, in the course of his travels, happened to arrive there the next day, and with great energy threw himself into the study of the causes of the disaster; these papers contain the results of his studies and observations. The first paper discusses the geology of the region and the forces involved; in the second, after giving a list of one hundred and twenty earthquakes, most of them destructive, which have occurred in Palestine and Syria from 1606 B.C. to February, 1928, he describes the effects of the recent shock, their distribution, and the causes of the distribution.

In crossing southern Palestine from west to east, we encounter first a coastal plain ten to fifteen miles broad limited on the east by chalk cliffs. Then comes an arch with gentle slopes rising to a height of 2600 feet, sloping down more steeply to the valley of the Jordan and the Dead Sea, and ending in cliffs opposite the latter. This is the Judean plateau. Opposite on the east, lies the Transjordan plateau which repeats the topography of the Judean plateau in the reverse direction, except that it does not descend to sea level but passes over into the Arabian plateau to the east. Between the two lies the Dead Sea and the valley of the Jordan. The surface of the Dead Sea is 1200 feet below sea level, and its bottom 2600 feet—a mile below the bounding plateaus. The distance between the opposing cliffs bordering the Dead Sea is about ten miles. Both plateaus sink towards the north. The Judean plateau divides into two spurs (separated by a broad structural valley), one ending in Mt. Carmel on the coast, and the other in Mt. Gilboa near the Jordan Valley. Immediately to the north the valley of Jezreel and the plain of Esdraelon form a lowland connecting the Jordan Valley and the Mediterranean. Still further north lies the hilly country about the Sea of Galilee.

The strata are of late Cretaceous age: in the south they are nearly but not quite parallel with the surface of the arches; west of the valley they are practically all limestone: east of the valley nearly all sandstone. Mr. G. S. Blake, the government geologist, considers the limestone and sandstone contemporaneous. The strata

rise more steeply than the surface on the western side of the Judean plateau and flatten out on the eastern side, suggesting that a gentle syncline originally separated the anticlines of the two plateaus. The relief shows that the surface of the plateaus is eroded to what Willis calls "matureland," to indicate a state somewhat less advanced than a peneplain. Such a surface must have been developed at a low level. The general geological history of the region now becomes clear: After deposition the late Cretaceous strata were raised above sea level and gently folded into two broad arches bearing some minor flexures and separated by a gentle syncline. Erosion, probably Post-Eocene, then reduced the whole surface to a matureland. Later there was renewed elevation of the arches and depression of the block between them, made possible by the development of great faults, a relation which still remains. The question arises, What were the forces which caused these movements and what was the type of the faults developed? The greater part of the paper is given up to a discussion of this question.

It has been generally assumed that the two great faults that bound the Dead Sea block are vertical or normal faults. Troughs formed in this way have been called "rifts" and are usually (but incorrectly) ascribed to tensions. Willis does not accept this explanation. He describes thrust faults at Mt. Carmel and Mt. Gilboa and finds other indications of compression in the Judean block; he concludes that the movements of the blocks are due to compression. Unfortunately, the main faults are not exposed; landslides and scree cover their outcrops. Willis places the origin of the compressive force under the Mediterranean. He thinks that the Judean block is bounded below by a great horizontal fault, which gradually curves upward to its outcrop at the end of the block. Below and in front of this is a second block, which is of course invisible and which he designates by the letter X. The friction between these two blocks is supposed to melt the rock (which is already near its melting point), and thus the Judean block could easily slide upwards on the fault surface. At the same time the pressure against X forces it downward to form the Dead Sea trough and presses it forward under the Transjordan block, raising the latter. Upcurving faults of this type are called "ramps" by Willis, and the valley between two such ramps is called a "ramp valley." Their existence naturally cannot be determined by observation, and the mechanics of faulting has not been developed sufficiently to show theoretically whether such faults can occur. The mechanics of the movements as given by Willis is too vague and too questionable to make his explanation convincing. This idea makes the elevation of the plateaus and the depression of X contemporaneous; but a study of the physiography of the stream gorges led Willis to the conclusion that the faulting occurred after the elevation of the plateaus. The discrepancy is not elucidated.

The second paper deals with the earthquake. What strikes one most conspicuously is the capricious way the damage was distributed. Three things determine the destructive effect of an earthquake: the intensity of the shock, the nature of the foundation, and the character of the construction. Willis gives an interesting description of building in the country. The poorer natives use mud; the more pretentious buildings have the walls faced with stone, which appears strong but is not; for the stones are cut in rough pyramidal form, the bases being at the surface, and the rest of the wall, perhaps three feet thick, is filled in with mud and rubbish. Where iron floor beams have been used in some modern buildings, they are not tied in but merely rest on the stone; they are easily dislodged and fall, carrying the floor with them. This is what happened to the Winter Palace Hotel at Jericho; and it was completely destroyed. The construction of the newer buildings in Palestine has not improved upon the older methods. It requires no prophet to foretell damage and loss of life in future earthquakes, even though they be not very severe.

The shock was strong at Jerusalem and also at Hebron, twenty miles to the south, though the damage is not reported. This is ascribed to a supposed fault running

along the crest of the plateau. The village on the Mount of Olives, ten miles northeast of Jerusalem, was destroyed; a fault has been recognized here. Lydda and Ramle, twenty miles west of Jerusalem on the chalk, were destroyed; whereas Jaffa, ten miles farther on the coast, and indeed all the coast cities were spared. A fault is suggested near Lydda and Ramle. Es Salt and Ammon, thirty miles east of Jerusalem, in Transjordania, suffered severely; this is ascribed to a local fault and a poor location. Nablus, thirty miles north of Jerusalem, was built across a valley. The parts on the hill slopes were not damaged; the part in the valley was destroyed. The foundation there was alluvium and the débris of earlier earthquakes. No comment is necessary. Reine, in the hill country near the Sea of Galilee was destroyed, though no other town in its vicinity suffered damage. The reason is obscure; but it is to be noted that Reine was destroyed by the earthquake of 1837. It was supposed at first that the earthquake originated in the Dead Sea trough, but the shock was not very strong there. The complete destruction of Jericho in this valley seems satisfactorily explained by the fact that it was built on alluvium and by the character of the construction. Willis thinks that the earthquake originated perhaps under the western part of the Judean plateau in a fracture due to compressive forces and that the vibrations were strong enough to cause local faulting at some places where the strains were already near the breaking point.

HARRY FIELDING REID

REPORT OF THE PALESTINE SURVEY COMMISSION

Reports of the Experts Submitted to the Joint Palestine Survey Commission. 741 pp.; maps, ills. Boston, Mass., 1928. 9 x 6 inches.

These reports made on behalf of the Zionist Organization deal with agricultural colonization, labor, and health in Palestine. The Agricultural Colonization Commission under the chairmanship of Dr. Elwood Mead outlines the general problem and makes recommendations. Details of the investigations of the several experts are given in appendixes thus: Economic Data on Jewish Agricultural Colonies in Palestine, by Frank Adams; Soil Reconnoissance, by A. T. Strahorn (compare his paper in this number of the *Geographical Review*); Horticultural Possibilities, by Knowles A. Ryerson; Irrigation and Water Supply, by Cyril Q. Henriques; Education and Research, by J. G. Lipman; the Jewish Settlements, by Sir John Campbell. Sir E. J. Russell contributes a report on his visit to Palestine in April, 1927.

A CITY GEOGRAPHY: MONTREAL

RAYMOND TANGHE. **Géographie humaine de Montréal.** 334 pp.; maps, ills., bibliogr. Librairie d'Action canadienne-française, Ltd., Montreal, 1928. $1.00. 7½ x 5 inches.

We have in this volume an interesting and fresh approach to the study of an urban community. Dr. Tanghe divides the story of the growth of Montreal in two parts. In the first, he considers the physical conditioning factors. In the second, he groups the human. He explains his method at length in the first chapter, which unfortunately is unconvincing. The virtue of the scheme is better demonstrated when he makes the specific application to Montreal, but even here his organization is confusing. Under *position* he includes matters of geographical landscape. Under *situation* he writes of ways of communication, local resources, demographic facts, and matters of economy. The second half of the book deals with commercial analyses, a discussion of house types, which does not seem of great importance, and the internal organization of the city. The author knows his city well, and the book is highly informational.

Yet the volume is disappointing. In spite of the pleasure one has in reviewing the information and the unconventional outline for urban studies, the discussion lacks the restraint which should mark a scientific thesis. One of the most interesting portions discusses the St. Lawrence waterway. The author sees, with the completion of the canals, traffic passing by the doors of Montreal as it now passes Quebec. Yet in the same breath he challenges the economics by which men argue that the lake cities may become seaports. He brands arguments which he opposes as ridiculous. In places the text takes on the nature of a philippic rather than an analysis. He scores a point when he says that Canada has little need of expensive construction of power development in the St. Lawrence when there is so much easily obtained power from the smaller streams to the north. Perhaps it is natural that he sees the question of the future of the St. Lawrence from a purely local point of view. As such, it is important. The book is nevertheless worth while, for it abounds in facts; and the opinions, acceptable or not, represent a point of view of the people of a great city who will be affected more than those of any other city by commerce and energy development from the St. Lawrence project.

RODERICK PEATTIE

A GEOGRAPHICAL STUDY OF FINLAND

EUGENE VAN CLEEF. **Finland—the Republic Farthest North: The Response of Finnish Life to Its Geographic Environment.** xv and 220 pp.; maps, diagrs., ills., bibliogr., index. The Ohio State University Press, Columbus, 1929. $2.50. 9 x 6 inches.

Mr. Van Cleef's little book, informed throughout with a friendly and sympathetic spirit, gives a well balanced picture of Finland. While the arrangement is more or less conventional the treatment is fresh, and encyclopedism is happily avoided by the selection of salient geographical facts. Thus the future of agriculture is discussed as regards "the national policy of forest conservation, the utilization of peat bogs, and the possible adaptation of crops to the environment"; in the chapter on climate the danger of frost, "the most disheartening obstacle with which Finnish life must contend," is stressed, methods of clearing to permit free air drainage are described, and tables of frost penetration are given. The overwhelming importance of the forest stands out. Over 73 per cent of the area of Finland is forest-covered; one-fifth of the total population is dependent on the wood-products industries; 85 per cent of the buildings in Finland are wood, and five per cent are timber in combination with brick or stone. An entire chapter is devoted to the coöperative societies that have had a marked success in promoting rural welfare. Under "seafaring activities" the ice problem of the Baltic and the creation of the free port of Hanko are noted.

Speaking of the settlement of the country, Mr. Van Cleef observes that the Finns did not at first occupy the areas of best soil and that psychological and traditional factors, if they may be so termed, still play no little part in guiding Finnish settlement both in Finland and in America. Prior to his visits to Finland (1923 and 1926) Mr. Van Cleef had studied "the Finn in America" (compare his paper of this title in the *Geogr. Rev.* Vol. 6, 1918, pp. 185–214), and he concludes his book with a chapter under the title "Emigration—the Finn in America."

The useful bibliography is prefaced by the note that much of the literature issuing from the country is propagandist in character but yet is distinguished by a high regard for the truth. Much of this literature, too, is by authorities of distinction. An instance in point is the Otava Publishing Company's "Finland—The Country, Its People, and Institutions" (Helsingfors, 1926) in which chapters on the geology are contributed by J. J. Sederholm (the ancient rocks) and M. Sauramo (the superficial deposits).

In addition to photographs there are many well conceived maps and diagrams,

though some of the maps suffer from the small scale of the reproduction. A clear general map (1:2,000,000) supplied by the Government of Finland is an excellent feature.

A Norwegian Plant Preserve

Rolf Nordhagen. **Die Vegetation und Flora des Sylenegebietes. I: Die Vegetation.** ix and 612 pp.; map, diagrs., ills., bibliogr. *Norske Videnskaps-Akad. i Oslo, Skrifter, 1927, Mat.-Naturv. Kl.*, Vol. 1, Oslo, 1928.

The Sylene region is in Norway, adjacent to the Swedish border, and a few miles south of the transpeninsular railway route from Sweden to Trondhjem. It was created a plant preserve in 1917.

The region is essentially a rolling upland, dominated by low rounded hills or small mountains, the range of altitude being from 720 meters (2300 feet) to 1700 meters (5600 feet). Lakes and marshes abound, and there are numerous irregularly disposed rivers and smaller streams. In short, the landscape everywhere bears evidence of glacial activity both of a local nature and in the form of ice sheets. Extensive boulder-strewn plains are bordered by splendidly developed alluvial terraces possibly representing the deposits of marginal lakes.

The scanty vegetation permits vast exposures of bed rock. The geology proper, however, is only briefly touched upon in the volume before us. More attention is given to the soil profiles and the effect of solifluction. The climate is relatively mild, the temperatures ranging from 18 above zero Fahrenheit during the winter to 52 during summer. The rainfall is moderate, averaging less than 25 inches a year.

The vegetation, which is of a decidedly arctic-alpine nature, is treated in detail under a subdivision into five major groups: birch woods; thickets of willows, dwarf birch, and juniper; dwarf shrub associations; grass and herb associations; and aquatic associations. A final section considers the distribution of the vegetation by subalpine and alpine regions.

A. K. Lobeck and N. C. Fassett

A General Work on Aerial Photography

Clarence Winchester and F. L. Wills. **Aerial Photography: A Comprehensive Survey of Its Practice and Development.** Foreword by Sir Alan J. Cobham; introductory notes by Sir Peter Clutterbuck and Sir Felix J. C. Pole. xvi and 236 pp.; diagrs., ills., index. American Photographic Publishing Co., Boston. $10. 10 x 7½ inches.

Aerial photography is a new science and an infant industry. As is usual in such cases, the literature on the subject is confined for the most part to highly technical papers or papers of a controversial nature which, though both essential and interesting to the expert, do not help the uninitiated student or the layman. Consequently a book in English which deals with the whole subject in a more or less popular manner is to be welcomed.

Though many of the chapters are interesting by themselves, the book as a whole is extremely uneven. Too much space is devoted in the beginning to photographic technique, most of which can be gleaned from any up-to-date textbook on photography. For instance, at the beginning of the chapter on lenses the authors say, "The general principles of optics as applied to lenses used in photography from the air do not in any way differ from the principles generally applied to lenses for terrestrial photography;" and yet seven pages are devoted to this subject. Later on in the book the chapter on "Geographical Application" is less than two pages long.

In Part III the authors have made the mistake of giving brief specifications of numerous apparatus on the market without any attempt at a critical analysis and yet without emphasizing that their survey is incomplete.

The sequence of certain chapters seems illogical, especially as regards the subject of aerial surveying. Chapter 12 is on map plotting, contouring, and rectifying apparatus, Chapter 13 on aerial cinematography, Chapter 14 on stereoscopic photography; but not until Chapter 19 do we get anything like a general account of the practical problem of aerial surveying. Much of the most useful material about aerial surveying is contained in Chapter 20, "Aerial Photography Abroad."

Attention should be drawn to the statement (p. 231) that "the greatest scope is to be found in unmapped regions where the camera can cover vast and valuable areas not easily accessible to ground survey or exploration parties. Undoubtedly it is in this direction that aerial photography has the greatest opportunity for practical development."

Without wishing to detract from the great importance of aerial photography in reconnaissance survey, it should be pointed out that this statement has not been in any way proved and is misleading in that it gives the impression that aerial surveying is only a substitute for ground surveys. It is much more likely that aerial photography will be found valuable for the reason that aerial surveying *combined* with a discriminating use of accurate ground control will eventually become the best and most economical method of surveying for all purposes and especially in highly developed regions.

In spite of these serious defects the book is useful in that it is bound to stimulate general interest in the subject. It is excellently produced, with remarkable illustrations.

CORRESPONDENCE

Dr. H. H. Clayton has sent the editor of the *Geographical Review* the following memorandum received by him from Dr. A. E. Douglass. It refers to Dr. Clayton's discussion of Dr. Douglass's report on the cyclograph at the Second Conference on Cycles (see *Geogr. Rev.*, Vol. 19, 1929, pp. 296–306).

"Just a memorandum regarding a sentence in the *Geographical Review* report of the Second Cycle Conference, page 298. It refers to your discussion after I had said something about the cyclograph to the effect that the various cycle methods of analysis, including the cyclograph, assumed constancy of phase. I wish to note here that one of the marked advantages of the cyclograph is that it does not assume constancy of phase, and change of phase is as apparent at once as change in length of cycle. If I remember rightly at the time of that discussion, after you had referred to this change of phase, I remarked that I had observed such changes also and, of course, I should have said at that time that they are as apparent as the cycle itself.

"But your remarks about the change in phase have helped me to take such changes more seriously. I have observed cases, as in the California big trees, where I could not get away from the change in phase, but yet it always made me feel a little uncertain, and I have left out some important references in some places on that account. I believe I have hesitated to put in print anything about change in phase; but there is a reference to it in Volume 1 of "Climatic Cycles and Tree Growth," page 102, middle paragraph, where the sunspot cycles show a reversal of phase between the early part and the late part of my 500 year tree records. I have never published some very striking phase changes in Sequoia records but in time I will get at them."

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OUR CONTRIBUTORS

PROFESSOR ALMAGIÀ, of the University of Rome, has very broad geographical interests. His work ranges from physical and human studies, especially of Italy and other Mediterranean countries, to investigations on the historical side, notably of the history of Italian cartography. He has done much to promote the advancement of geography in Italy. He is president of the committee for the bulletin and library of the Royal Geographical Society of Italy and joint editor with Attilio Mori of the *Rivista Geografica Italiana*.

DR. BELL has made extended geological explorations in various parts of Canada, including the Mackenzie Valley and Great Bear Lake, the results of his investigations being recorded in government reports and magazine articles. For several years he was director of the Geological Survey of New Zealand and has given an account of some of his travels in that country in "The Wilds of Maoriland" (1914).

MR. STRAHORN is attached to the Bureau of Chemistry and Soils of the U. S. Department of Agriculture. Much of his work has been in the examination and classification of lands in the arid west. He was a member of the commission of experts from the United States that recently made inquiry into the condition of the Zionist colonies in Palestine.

DR. PLATT is associate professor of geography at the University of Chicago. He has specialized in the study of Mexico and the Caribbean and during the last few years has carried out intensive field work in typical communities in Mexico and Cuba. He has also made a number of detailed regional studies in the United States.

MR. COSBY is a member of the Division of Soil Technology at the University of California. He has conducted a number of soil surveys and more recently has turned toward the subject of soil utilization. In addition to the work on the Laguna Salada region for the Mexican government he has made investigation of the desert lands about the Imperial Valley for the Bureau of Reclamation.

MR. MARTIN is an engineer and geologist. Much of his work has been done in the west of the United States including the California oil fields. In recent years he has been particularly engaged in exploratory work in Colombia and Venezuela.

PROFESSOR SHAW is in charge of the Division of Soil Technology at the University of California and also of the soil survey and related work for the state. He is keenly interested in the origin and mode of the formation of soils, particularly under arid conditions. He has made extensive studies of soils in the western states, in Mexico, in southeastern Australia, and in the Hawaiian Islands.

PROFESSOR SEMENOV-TIAN-SHANSKY is a son of the distinguished Russian geographer, Peter Semenov-Tian-Shansky. He is professor of geography in the University of Leningrad and president of the Faculty of Sciences of the Russian Geographical Society, collaborator of the Academy of Sciences, and director of the Central Geographical Museum, which he founded in 1919. His geographical work covers a great range (see "Our Contributors" for October, 1928).

PROFESSOR JEFFERSON is professor of geography at the State Normal College, Ypsilanti, Mich. His varied geographical studies include especially investigations into population distribution and climatology in its human aspects. Among his writings are "Principles of Geography" (1906); "Man in Europe" (1924 and 1926); and three works in the *American Geographical Society's Research Series*.

PROFESSOR JOHNSON is professor of physiography in Columbia University. In addition to numerous physiographic papers, he has written "Shore Processes and Shoreline Development" (1919) and "The New England-Acadian Shoreline" (1925). He has made a special study of the influence of physiography in the conduct of military operations. His "Battlefields of the World War" (1921) is No. 3 of the *American Geographical Society's Research Series*.

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